NEXT-GEN VR: HTC VIVE PRO REVIEWED

HIGH-END VR'S NEXT EVOLUTION

MORE PIXELS + HD AUDIO: IS HTC'S ENHANCED VIVE PRO HEADSET THE KICK VIRTUAL REALITY NEEDS?

apc

YOUR EXPERT GUIDE TO TODAY'S TECH

June 2018
Issue 455

AMD RYZES AGAIN

THE RED TEAM IS BACK WITH 2ND-GEN RYZEN!

CAN AMD's PUNCHY NEW CPUs & MOTHERBOARDS DELIVER THE KNOCKOUT BLOW IT'S BEEN HOPING FOR?

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UPGRADE YOUR TECH SKILLSET

- → CREATE A CHEAP AD-BLOCKER & FILE SERVER
- → PROPERLY SET UP iOS's 'DO NOT DISTURB' MODE
- → GET TO GRIPS WITH DOCKER & APP CONTAINERS

TEMPTING NEW TECH ON TEST

- → APPLE'S MOST-POWERFUL ALL-IN-ONE: NEW iMAC PRO
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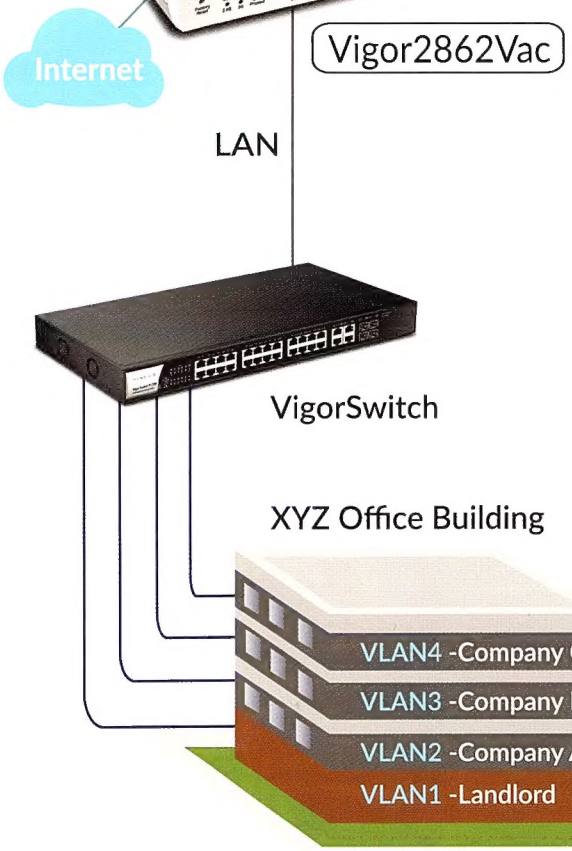

VLAN Features

- Supports up to 8 LAN IP subnets
- Supports up to 16 VLANs, ie up to 16 logical workgroups
- Additional security and traffic management
- IEEE 802.1q allows multiple VLANs to be connected on a simple LAN connection
- Applications examples:
  Separation of networks for tenants
  Staff in different locations can be grouped as same section

LAN >> VLAN Configuration

VLAN Configuration

☑ Enable

	LAN					VLAN Tag		
	P1	P2	P3	P4	Subnet	Enable	VID	Priority
VLAN0	☐	☐	☐	☐	LAN4	☐	0	0
VLAN1	☑	☐	☐	☐	LAN1	☑	10	4
VLAN2	☐	☑	☐	☐	LAN2	☑	20	1
VLAN3	☐	☐	☑	☐	LAN3	☑	30	2
VLAN4	☑	☑	☑	☑	LAN4	☑	40	3

- VDSL2/ADSL2+, Gigabit Ethernet WAN port, Dual USB ports for failover and load-balancing
- Two USB 2.0 ports for connection to two 3.5G/4G LTE USB mobiles, FTP server and network printer
- 4 x Gigabit LAN ports with multiple subnets and 50,000 NAT sessions
- Integrated IEEE 802.11ac (AC2000) wireless Access Point; dual band; up to 1.7Gbps throughput (ac & Vac model)
- IPv6 & IPv4. Increased IP addresses (1022) and IP subnets (8)
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- Object-based SPI Firewall and CSM (Content Security Management) for network security
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Tech and trust

Increasingly, our tech products need to collect some of our data to perform their core functions. But *APC* editor Dan Gardiner wonders if big tech deserves our trust...

Today's big tech brands need the trust of their users in order for their products to operate fully. When you use a free product, you're giving away some of your privacy in exchange, and this access to your data also allows (in theory) for deeper, more useful product personalisation.

If we don't trust Facebook, Google (and, to an extent, Microsoft) their ad-based business models would literally fall apart.

While we'll be taking an in-depth look at user privacy (and what you can do to safeguard yours) in a later issue of *APC*, most of the big tech companies don't score very well – either because they collect too much data, or don't do enough to protect it.

In fact, Apple seems to be the only big tech company that doesn't actively horde user data. An investigation of his own personal accounts by *USA Today* journalist Jefferson Graham found that Google and Facebook had amassed 243MB and 881MB worth of data respectively (including records of search queries, full chat logs, images and so on), Apple only had a piddling 9MB.

How much data these companies have about you depends in a large part on how much you use them, but there are still distinctions to data-collecting philosophies. For example, unlike Google, search queries made in wholly-owned Apple products like Siri aren't sent and saved in the cloud as part of a permanent record of your activity – that search data is stored locally. Granted, Siri queries are sent to the cloud for processing, but they're anonymised so that Apple doesn't know who sent them.

While some of Apple's business and design philosophy (such as its closed ecosystem that spits at non-Apple products) can be infuriating, the company is at least getting user-privacy right.

Facebook, on the other hand, just can't win. The company recently discovered that a male employee had been misusing his privileges to spy on female users. Said employee's since been fired, but it does underscore how important it is to adequately safeguard users' privacy protections (from both internal and external access). What's worse is that Facebook reportedly has its own internal alert system for staff, which will tell them if somebody's been snooping their profile – a tool that's not available to us mere mortals who fall outside the social giant's employ.

Actions speak louder than words, and while Facebook's almost constantly apologising, its actions don't paint a rosy picture of its attitude towards user privacy. ■

DAN GARDINER
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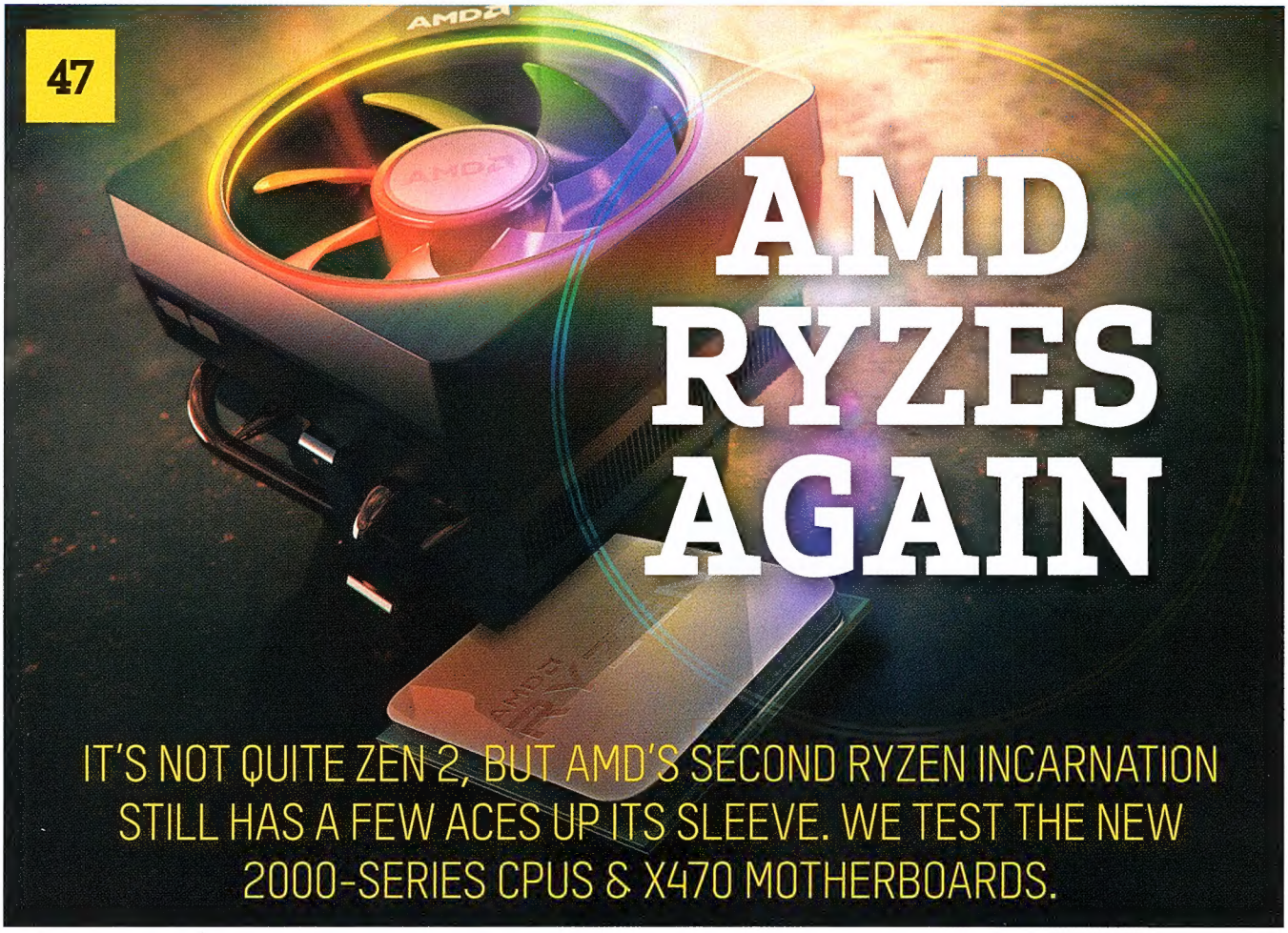
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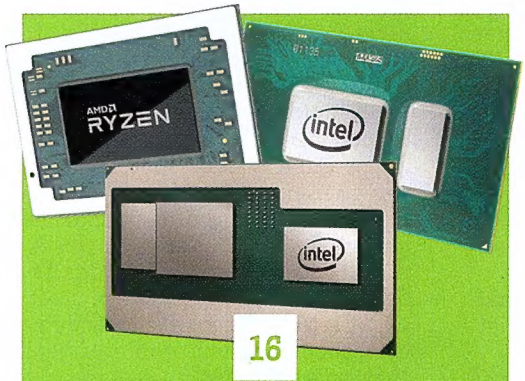

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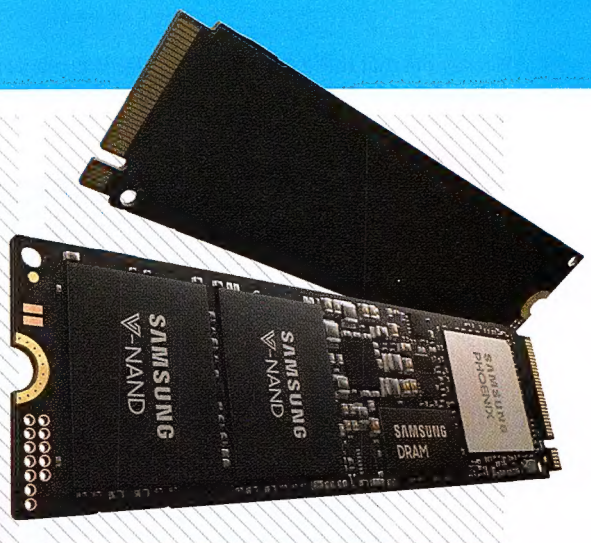

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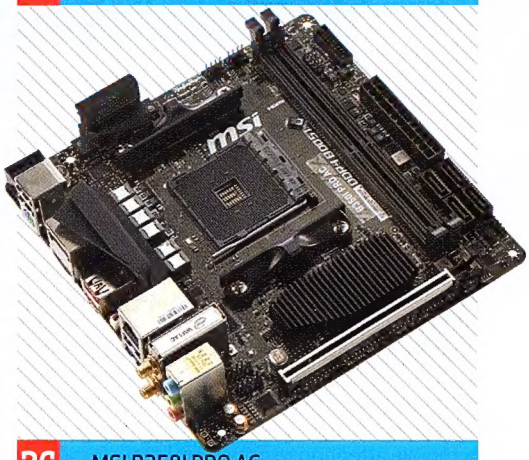

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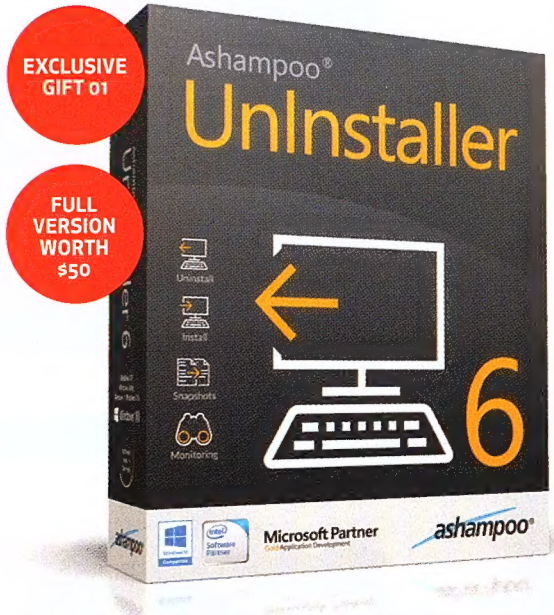

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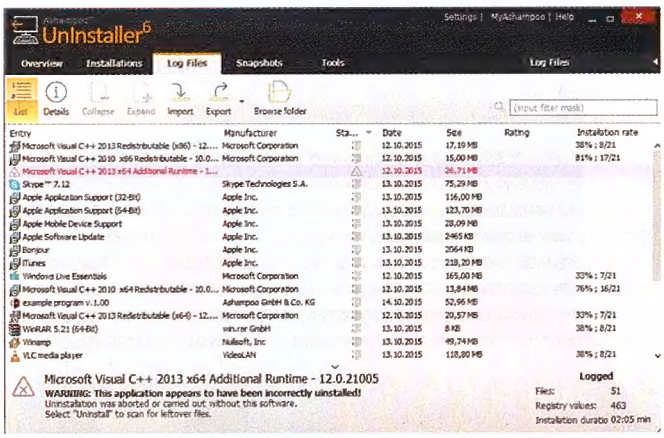

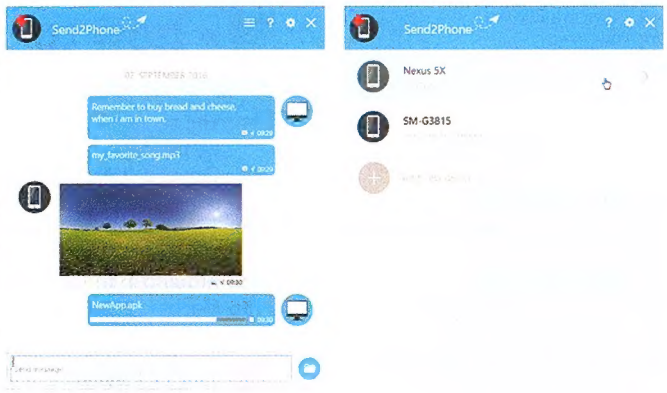

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technotes

» NEED TO KNOW

HP busted for bricking third-party printer inks in Australia

"DYNAMIC SECURITY FEATURE" IS A DELICATE NAME FOR IT.

Firmware for HP's OfficeJet ink printers was found to be automatically rejecting third-party ink cartridges and issuing false warnings of damaged cartridges in order to force customers to buy HP-branded cartridges. The ACCC has since found the practise of altering consumer's products, without warning and after purchase, to be unacceptable, and HP will be required to compensate affected customers to the tune of $50 each. The firmware has since been adjusted and warnings of the Dynamic Security Feature will be clearly visible. **HD**

AU Gov's facial-rec tech could lead to "authoritarian regime"

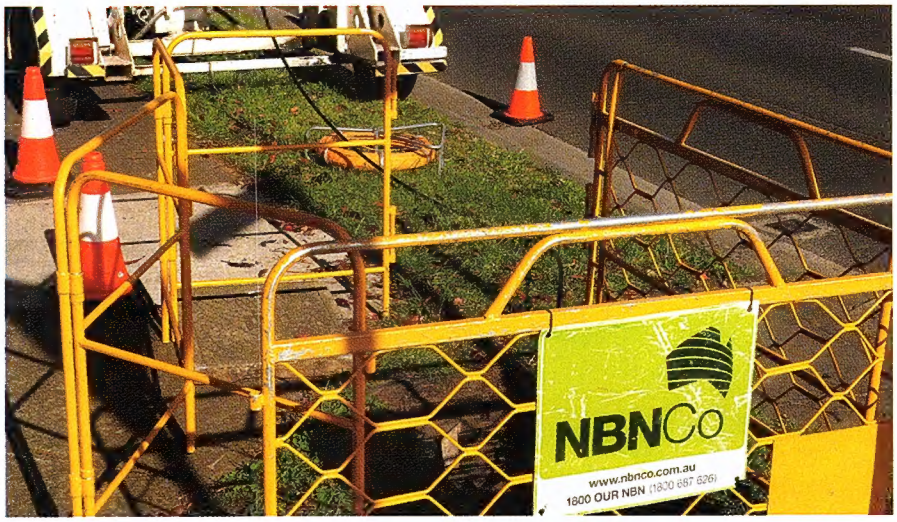
LAWYERS WARN AGAINST NEW SECURITY SCHEME.

Lawyers from the Law Council of Australia have warned that the nation-wide facial recognition database, which is used to tackle high-level crimes such as identity fraud and terrorism, could soon lead to widespread surveillance akin to what is currently in use in China. The Council is requesting that the "line between legitimate ... and illegitimate uses ... be clearly defined and assured by law". **HD**

Man suing France for allegedly stealing 'france.com' domain

HIS TOURISM WEBSITE HAS VANISHED.

After 24 years of running a tourism and travel booking site at the **france.com** web address, Jean-Noel Frydman has had the domain unceremoniously stripped from him, which now redirects to France's official English-language site, **france.fr**. Frydman is suing the French Government, as well as several hosting providers, in the hope that he can reclaim the domain and rebuild his formerly lucrative business. **HD**



Aussies are opting for faster NBN plans, but complaints still rising

The availability of higher speed plans is causing congestion, again.

The number of Aussies opting for the higher NBN speed tiers is increasing, according to the NBN Co's March 2018 report. More than a million premises have signed up for high-speed broadband in the last four months alone. That equates to 37% of homes and businesses now on the NBN50 option, as compared to just 16% from March last year. NBN Co claims that this surge is due to lower wholesale prices that have allowed resellers (RSPs) to purchase more bandwidth. But while the price cuts have led to easy access to high-speed internet, it's also increasing congestion during peak hours.

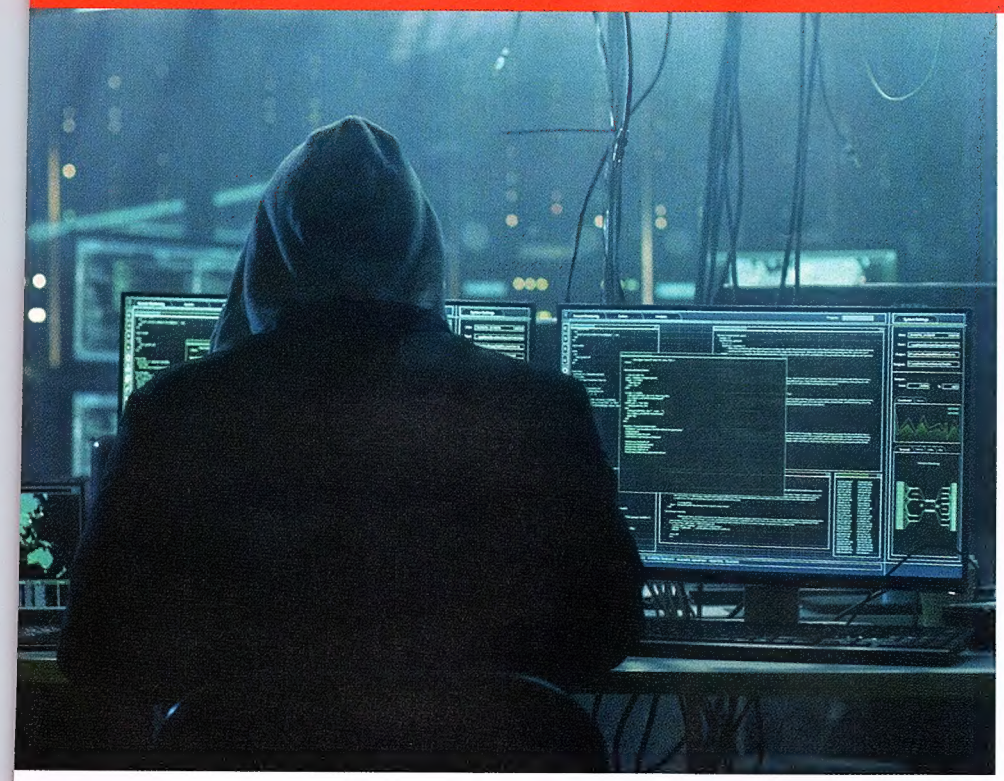
According to the report, average network congestion is now higher than what it was in February. That's not the only problem facing the NBN, though. The number of complaints about the national broadband service increased more than 200% in the last six months of 2017, according to a report filed by the telecommunications industry ombudsman. The report claims 22,827 complaints were lodged between July and December 2017. However, NBN Co is quick to point out that number of complaints was down by 16% in the last months of 2017. **Sharmishta Sarkar**

CBA defends silence after losing records of 20 million accounts

IS IT BETTER TO LET SLEEPING DOGS LIE?

After an exposé from BuzzFeed News revealed that the Commonwealth Bank had lost the data of some 12 million customers (across almost 20 million accounts) in May 2016, the Australian financial giant has released a statement in its defence. The data took the form of bank statements spanning the years 2000–2016 and was scheduled to be destroyed, but as no official documentation to prove that occurred was ever produced, its whereabouts is still unaccounted for. While the Commonwealth Bank claims the missing data didn't contain any information on customers' passwords and PIN numbers, it did contain their names, addresses, account numbers and transaction details.

The CBA has since released a statement to its customers, attempting to reassure them that there's "no evidence of customer information being compromised". The affected accounts were subject to elevated monitoring and an independent forensic investigation was immediately launched after the incident, neither of which found any signs of malicious activity. CBA notified the appropriate regulators of the potential breach but chose not to inform customers "in light of the investigation's findings". **Harry Domanski**



Major tech companies vow to prevent cyber warfare

No more meddling in their products, either.

While US President Trump's new national security advisor, John Bolton, has made clear that one of the ways to get back at Russia for meddling in US affairs is to launch "retaliatory cyber campaign", major global corporations are determined to not let that happen. 34 global corporations, including Microsoft, Nokia, Cisco, HP and Facebook, have signed the Cybersecurity Tech Accord, a pledge to ally together and defend consumers against cyber attacks. The accord states that the coalition "will not help governments launch cyberattacks against innocent citizens and enterprises from anywhere". The agreement will "empower civilians online" and "improve the security, stability and resilience of cyberspace", with each company promising to not aid governments bolster their cyber capabilities.

The companies have also promised to protect against "tampering and exploitation" of products and services by governments. The promise includes establishing stronger defences against malicious code, securing their own goods and services and improving "technical collaboration" and "coordinate vulnerability disclosures". **Sharmishta Sarkar**

New Facebook ad campaign admits social site lost its way

EARNINGS HAVE ALSO TAKEN A HIT, BUT USER NUMBERS KEEP RISING.

In the wake of the ongoing Cambridge Analytica scandal, Facebook has been trying to reassure both users and governments that the social giant takes its responsibilities seriously. The latest video released by the company is the closest it's come to admitting it has a serious image issue. "We came here for the friends", the video's voiceover begins, "Then we had to deal with spam, clickbait, fake news and data misuse. But from now on, Facebook will do more to keep you safe and protect your privacy."

Perhaps indicative of why an image repair-job is needed, Facebook's earnings fell in the first quarter of 2018 by $1 billion, after having consistently risen by between $1–2 billion each quarter throughout 2017. The company's quarterly report reveals that 98.5% of that came from advertising revenue.

Despite the drop in earnings, the number of daily and monthly active users continues to climb, with a jump of 50 and 70 million users, respectively, quarter-on-quarter. This brings the numbers up to 1.45 billion daily and 2.2 billion monthly active users. **Harry Domanski**

Valve fined $3 million for breaching Australian consumer laws

THE COMPANY'S DEFENCE HAS FINALLY RUN OUT OF STEAM.

Since 2014, the ACCC has been fighting a legal battle with Valve over the Steam gaming platform's lack of a refund policy, which contravenes Australian consumer rights laws. The High Court of Australia has recently upheld its December 2017 ruling on the matter, denying the appeal that the company has since made, and Valve Corporation will have to pay $3 million for breaching the Australian Consumer Law with "misleading or deceptive conduct". Steam officially begun offering refunds in 2015. **HD**

Intel delays 10nm Cannon Lake chips to 2019

SUFFERS YET ANOTHER SETBACK.

In its first-quarter 2018 earnings, Intel stated that it's "currently shipping low-volume 10nm product and now expects 10nm volume production to shift to 2019", which, according to analysts, is due to the need for further refinements in the 10nm tech itself. Cannon Lake processors were initially expected to start shipping in 2016, so Intel has had to repeatedly revise its chip-release strategy and schedule in response to the delayed technology. **HD**

Chinese PUBG hackers arrested, fined $5 million

CHEATING PROGRAMS CONTAINED TROJAN VIRUSES.

Chinese authorities have arrested 15 individuals that were suspected of developing and selling hack programs for popular online battle-royale game *PlayerUnknown's Battlegrounds (PUBG)*. According to the statement from Chinese authorities, some of the programs included Trojan horse viruses, which "developers used to control users' PCs, scan their data, and extract information illegally". As a result of the arrests, the suspects have been fined over $5 million. **HD**

numbercrunch

» HARRY DOMANSKI LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS

US$25 million

FORTNITE'S BATTLE ROYALE FOR iOS RAKED IN BIG DOLLARS IN THE U.S. OVER ITS FIRST MONTH

While *PlayerUnknown's BattleGrounds'* might be considered the first game to make 'battle royale' gameplay mainstream, *Fortnite* took the popularity of the mode and ran with it — and has managed to gain some serious traction. In its first 30 days, the iOS version has managed to rake in over US$25 million, according to analytics company SensorTower, which predicts it could be grossing more than US$500 million by the end of the year.

5%

NUMBER OF WEBSITES STILL USING FLASH PLAYER

In July 2017, Adobe officially announced that it will be retiring its Flash technology by 2020, but it may be gone well before then, with less than 5% of websites worldwide still running the media tech. Javascript is the preferred alternative for creating in-browser features these days, and popular browsers Chrome and Firefox are already phasing out support for Flash. The technology's last bastion is likely to be in dormant and abandoned websites, where it will stagnate, awaiting its official impending doom.

8,000

NUMBER OF POTENTIALLY MALICIOUS HACKING ATTEMPTS ON THE ATO'S SITE EACH WEEK

The Australian Tax Office has told a Senate inquiry that it experiences roughly 8,000 "potentially malicious exploitation attempts" on its website every week. While this may seem like a large amount, it comprises less than 0.001% of the billion or so connections the site has each week. Of these connections, 60% are people using the site as intended, legitimately, but the other 40% are allegedly "attempts to test the protective layers of ATO systems". Thankfully, those systems are catching such attempts.

47%

PROPORTION OF AUSSIE TRAVELLERS THAT RELY ON HOTEL WI-FI FOR FREE INTERNET ACCESS WHILE OVERSEAS

A survey of over 1,500 Aussies that regularly travel overseas has found that close to half of them would prefer to head back to their hotel room to use its Wi-Fi than any other free alternative. While this was a staggering majority of responses, the survey from Finder.com.au discovered that the next most popular source of free Wi-Fi was to hang around at a fast food restaurant... without buying anything. In fact, people would apparently sooner head to a shopping centre than buy a Big Mac to use some Wi-Fi. Can't blame them.

1,200

NUMBER OF NEWSAGENCIES AROUND AUSTRALIA RESELLING CRYPTOCURRENCIES

A partnership between Bitcoin and payment platform Blueshyft has enabled Aussies to purchase the cryptocurrency from over 1,200 newsagencies around the country, alongside another popular alternative, Ethereum. Customers are required to first install a digital wallet and sign up with Bitcoin Australia before they can place an order online, at which point, they'll receive a QR code that they can take into the newsagency to turn the handed-over cash into Bitcoin or Ethereum. ■

techbrief

» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK

AI and VR in the real world

The everyday uses for the tech on the cutting edge.

Beyond the vivid imagination of Hollywood writers and computer game developers, AI and VR lead pretty peaceful lives. Rather than causing the annihilation of the human race (well, not yet anyway), AI is busily going about many useful tasks, from sifting through documents for certain terms to making up cookie recipes and sorting out Lego pieces.

VR, too, has many uses for us squishy humans beyond gaming applications. In fact, it's these alternative uses for the technology that are the most interesting at the present time. With both AI and VR lending a hand in the medical profession, crime fighting and education, it truly is an exciting area to explore.

We've touched on virtual reality and artificial intelligence many times in this column, but what the hell, let's do it again! Here are four more examples of the great leaps and bounds the tech is making.

Midwives trained using VR at Newcastle Uni

Students getting the very best that modern training can offer.

The University of Newcastle has created a VR app to help midwifery students further develop their resuscitation skills on newborns, setting up a realistic environment with a lifelike patient and recreating time pressures. The result of this app is that students now have greater access to training and, therefore, more experience and confidence. In similar news, the university has also developed a VR program called Road to Birth, which provides information on all the stages of pregnancy for both students and parents. With anatomical diagrams and detailed explanations, this program — combined with the aforementioned hands-on app — looks to boost midwifery student education in a big way.

NASA enlists Google AI to find other solar systems

Last December, Google and NASA announced the discovery of an 8th planet in the Kepler-90 system, which was actually uncovered by one of Google's machine learning algorithms using the existing Kepler dataset. While the smaller planet's effect was so subtle that it eluded mathematical detection by a human eye, Google's AI software sniffed out the anomaly and found itself a new job in the process.

ElliQ – the social robot for the elderly

This little AI bot has been designed to "encourage an active and engaged lifestyle" for older adults. Specifically focusing on social interactions, ElliQ will suggest activities to keep their human "sharp" and "active", be able to understand body language and also adapt to their human's own personality. As well as making sure their companion can access the necessary services, they will also encourage them to contact their families. Sounds lovely!

US skiers take to the virtual slopes with VR

Some sports are easier to practise for than others, but for athletes tackling ski routes (that are different courses for each tournament), they usually rely on their memories from the few test runs they're allowed to undertake. Not so for Team USA in 2018's Winter Olympics. The team filmed the course using a GoPro Omni, capturing a 360° video, which their contestants then used via VR to practise away from the course. Ingenious, but it didn't get them to the top of medal tally! ■

gadgets

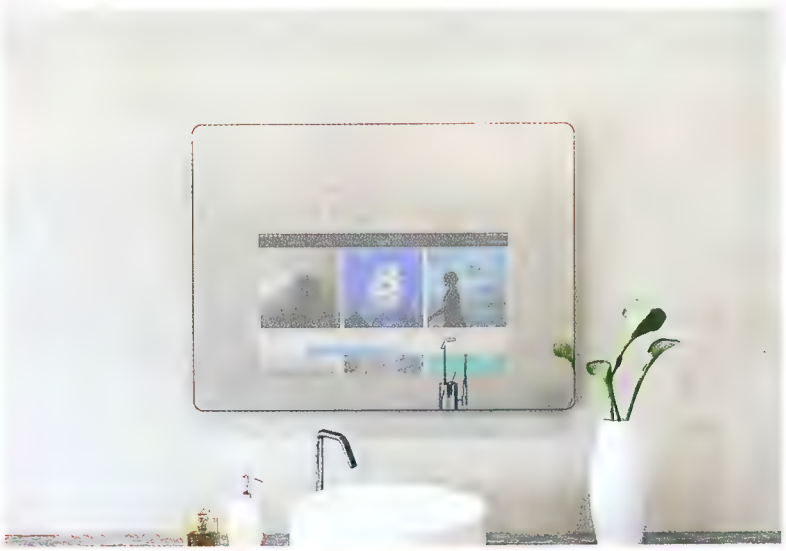
» GEAR WE WANT

AMAZON ECHO SPOT

Do you have a soft spot for smart speakers?

$199 | AMAZON.COM.AU

Smart speakers are pretty good at talking these days, but if a picture paints a thousand words, then Amazon's new Echo Spot is the most 'talkative' smart speaker to land in Australia to date. As the first digital assistant to come with its own built-in screen, the Echo Spot is able to show you anything from the weather to your calendar, in addition to all the handy features your existing smart speaker can do. The touchscreen can even be synced up to security cameras, baby monitors and your smartphone contacts to help you keep an eye on the important things in your life. Plus, it looks quite swish. **JB**



EMBRACE SMART MIRROR

Tech for the man (or woman) in the mirror.

$1,699 | WWW.EMBRACESMARTMIRROR.COM

Considering not everyone in Australia has a smart speaker yet, the need to own a dedicated 'smart mirror' is perhaps still a little way off. But that doesn't mean you can't get on that bandwagon early, with this bedroom or bathroom mirror integrating a voice- and touch-controlled screen section. The 80 x 60cm mirror has a 20.3-inch Android tablet embedded into the glass, giving you the full functionality of Google's mobile operating system. While this functionality obviously includes Google Assistant compatibility, you can also use its generously sized screen to take selfies and watch movies... or basically anything an Android-based tablet can do — all while potentially on the bog. **JB**

FITBIT VERSA

Fitbit adds another verse to its smartwatch song.

$299 | WWW.FITBIT.COM/AU

Less than six months since the launch of its first smartwatch, the Ionic, Fitbit has released a follow up device that offers almost all the same features — and for $100 less. The main concession of the Versa is that it loses the full GPS tracking of the Ionic, defaulting to smartphone-connected GPS, which means you have to carry your phone for mapped exercise. Considering it keeps other features like 50m (or 5 atmospheres) water resistance, four-day battery life, heart-rate tracking, cardio fitness level, 4GB of locally stored music, Bluetooth, NFC payments and sleep tracking you aren't actually missing out on much, though... **JB**

PETZL REACTIK+ HEADLAMP

Smart lighting for on and off-trail.

$190 | WWW.SPELEAN.COM.AU

The humble headlamp isn't the sole domain of adventurers and outdoor enthusiasts any longer. Nor is it about pumping out as many lumens as possible – although the Petzl Reactik+'s 300 lumen lamp basically turns night into day. No, what makes this headlamp really neat is a front sensor which can adapt the intensity and beam pattern of light to maintain visibility, while also optimising life of the rechargable battery. There's a companion app for both iOS and Android that lets you connect to the headlamp via Bluetooth, where you can monitor battery life and switch between preset performance profiles tailored to specific activities such as bushwalking, trail running and trekking. There's also a slider that allows you change beam intensity on-the-fly. A great addition to anyone's outdoor – or indoor – kit. **TC**

UBTECH JIMU ROBOT ASTROBOT KIT

A 3-in-1 DIY robot kit.

US$200 | JIMUROBOTS.COM

With the UBTECH Jimu Robot AstroBot Kit, you can build not just one robot but three: AstroBot, Rover and Astron. Or if you want to get really creative, you can build and program a robot of your own design using the app. Whether you want to make your robot a friendly humanoid or a wheeled vehicle, they're so much fun, it is easy to forget that you're learning STEM skills as you build! You can utilise the infrared sensors so your bot can pick up objects, install some treads to tackle tough terrain, or use the speaker to play music or sound effects – the possibilities are endless. The free Jimu app offers step-by-step 3D, 360° animated building instructions, and you can use Blockly coding to program AstroBot to do almost anything.

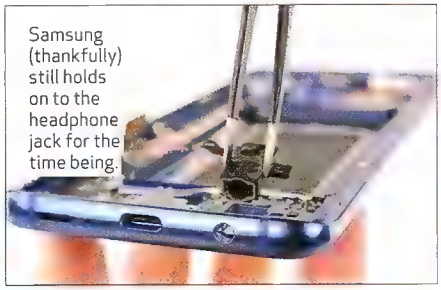
BENQ TK800

Makes staring at the wall entertaining.

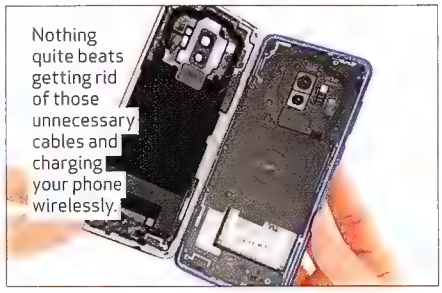
$2,500 | BENQ.COM.AU

Sometimes, even a 65-inch TV won't do justice to your favourite shows, films or sporting events, especially when you're all crowded around it. The solution? A projector to beam the drama onto your nearest wall. Whether you're hosting a viewing party in your lounge or garden, BenQ's TK800 DLP projector delivers a 100-inch+, 8.3 million pixel, 4K 3,840 x 2,160 UHD picture, while projector-optimised HDR and 3,000 lumen brightness buddy up for premium colour and clarity. Image-boosting Football and Sport modes will appeal to A-League and World Cup fans, too. Couple that with a CinemaMaster Audio+ 2 sound system, plus high brightness, and your home cinema is in for a significant boost. BenQ's latest projector is due to be released in Australia about the time you read this. ■

howit'sdone



Samsung (thankfully) still holds on to the headphone jack for the time being.



Nothing quite beats getting rid of those unnecessary cables and charging your phone wirelessly.

Samsung Galaxy S9+

Samsung's latest flagship is as tricky as ever to deconstruct.

While phone makers and operating system developers of dubious numeracy skip straight from eight to ten, Samsung stays strong and gives us the Samsung Galaxy S9+ (sans notch, even). Only a teardown will tell if this phone is a true contender, or just a weird AR Emoji machine.

MAJOR TECH SPECS:

- Notchless 6.2-inch AMOLED display with resolution of 2,960 x 1,440 (570 ppi)
- Qualcomm Snapdragon 845 or Samsung's Exynos 9810, depending on location
- 12MP OIS dual-aperture main cam – f/1.5 and f/2.4 modes – plus a 12MP 2x optical zoom secondary camera, and 8MP selfie cam
- Headphone jack and microSD slot
- IP68 water/dust-proofing rating
- Android 8.0 Oreo

KEY FINDINGS:

- While it's no S4, the S9 is a welcome respite from our more recent destructive teardowns. The standard application of heat and opening pick helps us along, but it's definitely no picnic! Thanks to prior experience – no thanks to Samsung – we are able to safely dispatch the sensor assembly cable with no casualties.
- We head straight to the rear camera to get a look at the fancy new dual-aperture camera in action. The camera auto-adjusts the aperture to adjust for low light (at f/1.5, it's got the widest aperture of any phone), while maintaining a more standard (and sharper) f/2.4 for normal photos.
- What do you need to remove a glued-down battery from a Galaxy phone? Option one: lots of heat, a pry tool, a fire extinguisher, a bucket of san, and nerves of vibranium. Option two: a syringe loaded with a little iFixit Adhesive Remover. We opt for the latter, and splash a bit of the blue stuff into the little tub that cradles the battery. A few minutes later, we have our prize.
- It's a hotbed of teardown activity as we attempt to unseat the display – but this glue is trying our patience, and we abandon our pile of iOpeners in favour of a heat gun once again. As before, the heat and opening pick can do the job, but it's a marathon slog to get here if you're replacing a broken screen. The Samsung-made display cable, like the cameras, is labeled "Star" and combines both display and digitiser in one sealed unit.
- **Repairability Score:** 4 out of 10 (10 is easiest to repair). Many components are modular and can be replaced independently. The battery replacement is technically possible, but accessing it is an unnecessary challenge. Glued-down glass both front and back means greater risk of breakage, and makes repairs difficult to start. Screen repairs require a lot of disassembly while battling tough adhesive. ■

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit: **www.ifixit.com**

NEXT-GEN VR: HTC VIVE PRO REVIEWED
apc
June 2018
Issue 455
YOUR EXPERT
GUIDE TO TODAY'S TECH
AT-HOME VR'S NEXT EVOLUTION
MORE PIXELS, NO WIRES: IS HTC'S ENHANCED VIVE PRO HEADSET THE KIT VIRTUAL REALITY NEEDS?
AMD RYZES AGAIN
TEAM'S BACK WITH 2ND-GEN RYZEN!
NEW MACHINE LEARNING MASTERCLASS!
DARREN YATES' EXPERT GUIDE EXPLAINS HOW TO GET STARTED CODING YOUR OWN ARTIFICIAL INTELLIGENCES
DIY RASPBERRY PI POWERED ROBOT
ROLL UP YOUR SLEEVES & BREAK OUT THE SCREWDRIVER! WE REVEAL HOW TO MAKE YOUR OWN PI-BASED ROBOT
IN AMD'S PUNCHY NEW CPUs & MOTHERBOARDS FINALLY DELIVER THE KNOCKOUT BLOW IT'S BEEN LOOKING FOR?
FUTURE
UPGRADE YOUR TECH SKILLSET
CREATE A CHEAP AD-BLOCKER & FILE SERVER
PROPERLY SET UP IBS'S 'DO NOT DISTURB' MODE
GET TO GRIPS WITH DOCKER & APP CONTAINERS
TEMPTING NEW TECH ON TEST
APPLE'S MOST-POWERFUL ALL-IN-ONE: NEW IMAC PRO
SAMSUNG 970 NVMe SSD: WRITING NEW SPEED RECORDS
IRIS IS BEAUTIFUL: VIEWSONIC'S 38-INCH CURVED 4K DISPLAY

the lab
» LATEST REVIEWS
VR HEADSET
HTC Vive Pro
Next-gen VR brings perfectly clear visio... ...omfortable headset
The HTC Vive has always been the leading virtual reality experience when it comes to room-scale immersion. Although rival headsets such as the Oculus Rift have since expanded to help you physically move around, and the PlayStation VR does it to a point, no other headset has quite been able to replicate what the Vive offers.
TECHNOLOGY
HTC is now launching the Vive Pro, an upgraded headset with higher-res displays and a more ergonomic design. On the tech side, there are two big changes. First is an increase in pixels, climbing to 2,880 x 1,600 (1,440 x 1,600 per eye) and representing a 78% increase from the original. Second is high-res audio headphones built into the headset. But after you've forked out the staggering $1,199 price you might be surprised as to what you actually get in the box–just the headset, the link box, a DisplayPort and USB cables for connecting the Vive Pro to your PC, a power adapter and the mounting pad for strapping down that link box. That's it.
To actually use the Vive Pro, HTC is expecting you to already own the pair of controllers and the two base stations required for tracking your movements. There is a bundle that gets you all of the necessary kit in one box, though, with two Vive 1.0 controllers and two 1.0 base stations for a total of $1,999 – a rather large investment.
ROOM WITH A VIEW
The good news is that the Vive Pro will work perfectly with your existing Vive kit, so it's just a matter of swapping out the headsets and link boxes to use in your VR space.
If you're new to the VR game, you need to prepare for what a faff it is getting everything set up properly. You have to download the drivers from the HTC Vive website, run the setup software and get everything plugged in. Then you must position the sensor units up high enough by balancing them on bookcases, tripods or screwing them into your walls; map the space that you want to use to play Vive Pro games; then finally run through the tutorial. That's before you factor in whether you'll need to clear extra space in your room to properly play. There's a standing-only option if you have a small space, but for the true Vive experience – one that makes it worth the big outlay – you'll need a space at least 2 x 1.5m.
For a lot of AU homes, keeping that much room clear on a regular basis isn't easy. And it doesn't help that, despite running the room set up several times over the course of testing, the software kept shifting our play space to the right, putting us in constant proximity to breakable things, such as our fish tank.
The tracking isn't always perfect, occasionally losing sight of one or both controllers mid-game. In fact, it's a little immersion-breaking when you're trying to take on a swarm of aliens in Doom VFR. Regardless of the complexity of the setup, there's nothing more rewarding in games than the virtual experience the Vive Pro has to offer when it's in full swing. The difference between the first Vive and the Pro is staggering.
LAST WORD
The biggest upgrade is the improved sharpness. The twin OLED screens don't just deliver a higher-resolution experience overall (the original Vive's resolution
28 www.apcmag.com

Inside APC

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

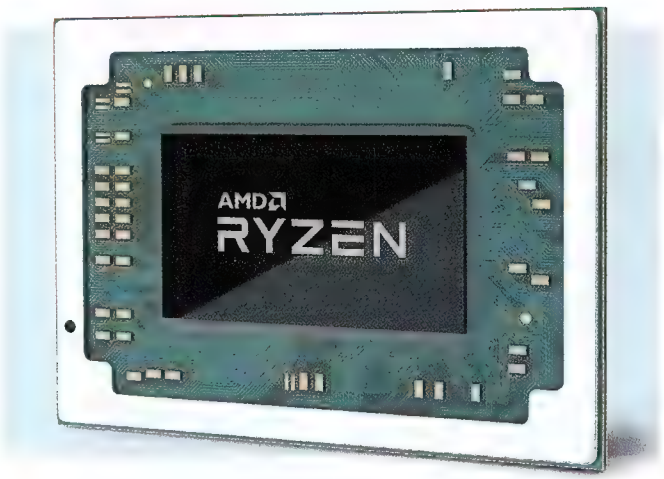
Despite being a small magazine with limited resources, *APC* still still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

Head to head: Mobile CPUs

Jeremy Laird heads to the lab to pit the big boys of the portable processors against one another in a battle to the death. Which will come out on top — AMD's Ryzen or Intel's 8th gen CPUs?



Is AMD's Zen architecture as awesome on the move as it is on the desktop?

With the arrival of mobile variants of AMD's Ryzen chips and laptop variants of Intel's 8th-gen Core CPUs, there's some serious competition in the portable processor market. That's good news, and with it comes a few questions. For instance, does AMD's Zen architecture work as well on the move as it does on the desktop? And who makes the best processor for a wide range of portable applications? We'll also try to make sense of how these chips fit into the idiotic array of CPUs that Intel has drawn together under that '8th Gen' banner.

Round 1

PRODUCT RANGE AND BRANDING

For some time, the weakest element of Intel's operation has involved branding, marketing and product positioning. The underlying hardware has been fantastic. However, the problem has extended beyond the ridiculous product names. Not even the fact that Intel offers the thick end of 200 desktop and mobile CPUs is the worst aspect of all that, even if that makes it almost impossible for any normal human being to keep track of Intel's CPUs, and actually understand what they are buying.

No, it's the fact that the marketing guys force infuriating decisions — like preventing most of Intel's CPU from being overclocked, or switching off HyperThreading — that grates most. Intel's 8th-gen chips are a case in point. '8th Gen' covers at least three distinct CPU architectures and, thus, means nothing. The small mercy is that, for now, '8th Gen Mobile' is restricted to just 10 CPU models, so is just about comprehensible. This will not, obviously, last.

AMD offers just four Ryzen Mobile chips, and they almost all make sense. Only the Ryzen 3 2300U with its disabled multithreading stands out as suffering from the sort of marketing non-finesse that threatens to ruin Intel's products.

WINNER:
AMD by a mile

Round 2

PERFORMANCE

In terms of grunt, there's no competition. The range-topping beast of Intel's new 8th-generation mobile range is the Core i9-8950HK, and it simply cannot be beaten. Along with the equally new Core i7-8850H and Core i7-8750H, it's based on Intel's very first six-core mobile CPU. The Core i9 model is nominally clocked at 2.9GHz, with a maximum Turbo frequency of 4.8GHz. Much, of course, will depend on specific implementation and the cooling efficiency of a given laptop fitted with the 8950HK, but those are some fairly serious numbers.

We haven't had a chance to do a direct comparison yet with AMD's finest, the quad-core Ryzen 7 2700U. However, that APU is both lower clocked and has fewer cores and threads. The Zen architecture also typically does a little less work per clock than a modern Intel Core CPU. So the 2700U isn't in the hunt regarding outright performance. We estimate the Core i9-8950HK to be in the region of 50% faster. That said, at any given price point that AMD's chips operate, you may well find the performance of Ryzen mobile to be entirely compelling. Quad-core versus quad-core is a very interesting comparison. Which brings us neatly to the question of value.

WINNER:
Intel by a conclusive margin

Round 3

VALUE

Picking the best value proposition when it comes to mobile processors has always been a pain. That's because laptop PCs are much more highly integrated than desktops. Yes, it is possible to buy a whitebook system and add components, including a CPU, but you're much more likely to be buying the whole laptop, full specced, and ready to go. Moreover, laptops powered by AMD and Intel chips haven't always competed directly in the same market segments, with AMD systems tending to be low-cost.

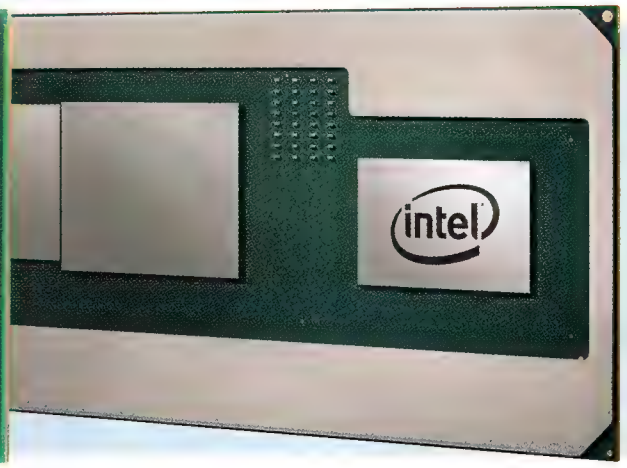
With all that in mind, where does the best value lie? In theory, the new AMD Ryzen APUs make for a great all-round package that combines strong CPU performance with far superior graphics performance compared to Intel CPU models with Intel graphics (Intel's Kaby Lake G chip have AMD graphics, but are far more expensive).

In practice, there are very few laptops to choose from with the Ryzen chip. Meanwhile, there are zillions of Intel laptops, and that means more choice, more economies of scale and, ultimately, better deals. That said, if a given Ryzen-powered portable rig just so happens to precisely match your spec requirements, it might just deliver the best bang for your buck.

WINNER:
Intel, thanks to more choice

"In terms of grunt, there's no competition. The range-topping beast of Intel's new 8th-generation mobile range is the Core i9-8950HK, and it simply cannot be beaten."

Intel's 8th-gen mobile CPUs are lost among hundreds of other Intel models.



Shock tactic: Intel added AMD graphics to its own Kaby Lake G processors.

Round 4

EFFICIENCY

Of all the categories here, efficiency has to be the easiest to call. That's because AMD simply doesn't operate in the really low-power parts of the market that are dominated by Intel's ultra-low voltage chips. Put simply, only Intel can provide CPUs to enable the thinnest and lightest of notebooks. The problem for this comparison is that Intel hasn't yet released 8th-generation versions of its most efficient Core M processors.

That said, there is a number of 8th-gen U Series chips from Intel that represent its second-most power-efficient offering. As it happens, those U Series Core processors line up fairly neatly against AMD's Ryzen mobile APUs. Both Intel and AMD offer dual-, quad- and six-core processors, and all are rated at 15W TDP, officially. But which is more efficient?

As ever, picking the question apart is awfully hard, given that laptop design plays such a major role. Handily, HP currently offers the Envy x360 laptop with both CPU options. In independent testing, the battery life performance was too close to call. For now, then, it's a dead heat. However, when Intel refreshes its Core M line with 8th-gen chips, AMD won't have anything with which it can compete.

WINNER:
Tie

Round 5

GRAPHICS AND GAMING

For once, we have a clear winner. And it's Intel. Actually, it's AMD. Allow us to explain. Late last year, Intel rocked the PC community with an announcement involving a single processor package that combined one of its own quad-core CPUs with an AMD Radeon graphics die. The result, codenamed Kaby Lake G, is part of the 8th-gen Core range, and aimed at creating a new class of thin-and-light gaming laptop. It's also the fastest integrated graphics solution yet, albeit the graphics is integrated into the processor package, not the CPU itself.

Known as either a Core i7 Processor with Radeon RX Vega M GH graphics or Intel Core i5 Processor with Radeon RX Vega M GL graphics, you get either 20 of AMD's Vega graphics processing compute units or 24. That compares with a maximum of 10 Vega compute units in AMD's Ryzen mobile APUs.

Admittedly, there's some debate over whether the graphics in the Intel package is truly AMD's latest Vega tech. But either way, the AMD graphics in the Intel package is clearly the more powerful proposition. Equally either way, then, it's AMD that has the most powerful graphics. Or rather Intel. You know what we mean.

WINNER:
Intel via AMD. Or is it the other way around?

And the winner is...

Despite our reservations regarding the way it markets and positions its products, the overall result is clear. Intel wins. For the most part, that reflects Intel's much broader product offering. AMD has a single APU die that does duty for its entire range of mobile processors. It does not, for instance, offer any ultra-low voltage parts. Strictly speaking, Intel's 8th Gen Mobile range only consists of 10 models, and it too lacks models designed to go into the thinnest and lightest of portables. But it's still a broader and more capable range of mobile processors.

That gap will only grow as Intel further fills out the 8th Gen family with more and more models. On a similar note, there are simply far more Intel-powered laptops to choose from. Whatever you think of the CPU comparison, the rest of the package may well force your hand.

There is, however, a caveat to all that. Where and when AMD does offer a Ryzen Mobile model, it will often be very competitive. If the spec happens to fit your needs, a Ryzen-powered portable may well be the most appealing proposition. ■

opinions

"When the boss comes a-tapping, the little zone bubble needs to pop."

IN THE HEADPHONE ZONE

I was talking with my husband the other day – he's a graphic designer – and he mentioned a few unspoken rules that his office colleagues all adhere to. One of them in particular stuck out as something that I would dearly love to implement somehow in my own office: "If the headphones are on, I'm in the zone, don't disturb me." I unfortunately work in an office where interaction with my colleagues is part of the job, so there's little opportunity for me to get 'in the zone' for a couple of hours and really smash out some work. Someone will inevitably tap me on the shoulder to talk about something... work-related or not. The best I can do is put my Mac in Do Not Disturb, which disables all the chat and email notifications I get from my colleagues – most of which don't apply to me anyway – and allows me to concentrate. But perhaps I could stick a post-it note on the back of my head that says: "I'm in the zone, go away!" instead. I wonder whether it's just an industry thing – that designers, developers and engineers respect the need to get 'in the zone' more than people in say, sales, journalism, banking or otherwise...

What's it like in the *APC* moshpit? Surely, some of you lot can get 'in the zone', what with all those tutorials and reviews you're writing up each month! Would be interesting to get some insight into how to enforce certain office-based courtesies such as this.
Tom Burgmann

Ed replies: *It sounds as though our office is similar to yours, Tom, in that interaction between our writers is often quite beneficial; but yes, getting 'into the zone' as you say, is also very necessary to actually get some words down on paper. Where possible, we try to respect the 'headphones on, leave me alone' principle, but many of our writers also have to receive calls from PR, make calls themselves, go into meetings, work collaboratively with each other and discuss upcoming reviews or articles with supervisors, managers or our sales team.*

After having a quick ask-around (interrupting a couple of people writing up stories, of course!), we found that most of our writers will use noise-cancelling headphones if they have them, then listen to either their favourite music, or specific music that won't disturb them (ie, tracks with no lyrics or, for one weirdo who shall remain unnamed, songs sung in foreign languages).

As to our methods of keeping 'in the zone', however, there's sadly no flawless approach. When the boss comes a-tapping, the little zone bubble needs to pop. Still, it clearly works, as we're able to provide our APC readers with a mag to dig through each month!

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

SHAUN PRESCOTT DIGS INTO THE BIG TECH ISSUES AFFECTING CONSUMERS

The Internet of Things leaves privacy and security behind

Shaun Prescott reports on a study that found some worrying trends among IoT devices.

When you unbox a Samsung smart TV and turn it on for the first time, companies including Google, Facebook, Netflix, Spotify and more are alerted to the occasion. And that's before you've logged in or even expressed an interest in using any of those services: the TV does all this automatically.

The Internet of Things is meant to streamline our domestic lives and, let's just admit it, make us feel like the Jetsons. But according to a new tool created by Princeton University's computer science department, a whole range of IoT devices pose significant privacy and security risks. And while the Samsung example above probably won't ring alarm bells for most (who doesn't already volunteer all their intimate information with Google and Facebook?), it's the shadier and more ambiguous ways information is shared with third-parties that might result in the worst breaches.

Princeton tested 50 widely used IoT devices, ranging from smart TVs and security cameras through to light bulbs. One of the overwhelmingly common scenarios were communications with third-party services. The use of these is rarely mentioned to the consumer, but that's hardly the worst thing about it.

"These third-party services are potentially single points of failure or vulnerability," a document issued by Princeton reads. "Specifically, the same third-party services are often used by a broad array of IoT devices. A security vulnerability in one service might affect devices across a range of manufacturers. Third-party services also allow data aggregation across devices. A third party could aggregate user data from a wide range of devices, creating the possibility for tracking a user's behavior across many devices."

It continued: "These devices are also not transparent about the internet services with which they communicate or share data. Most IoT devices do not mention the specific third parties they communicate with in their privacy policies, which makes it difficult for consumers to make purchasing decisions based on security and privacy considerations."

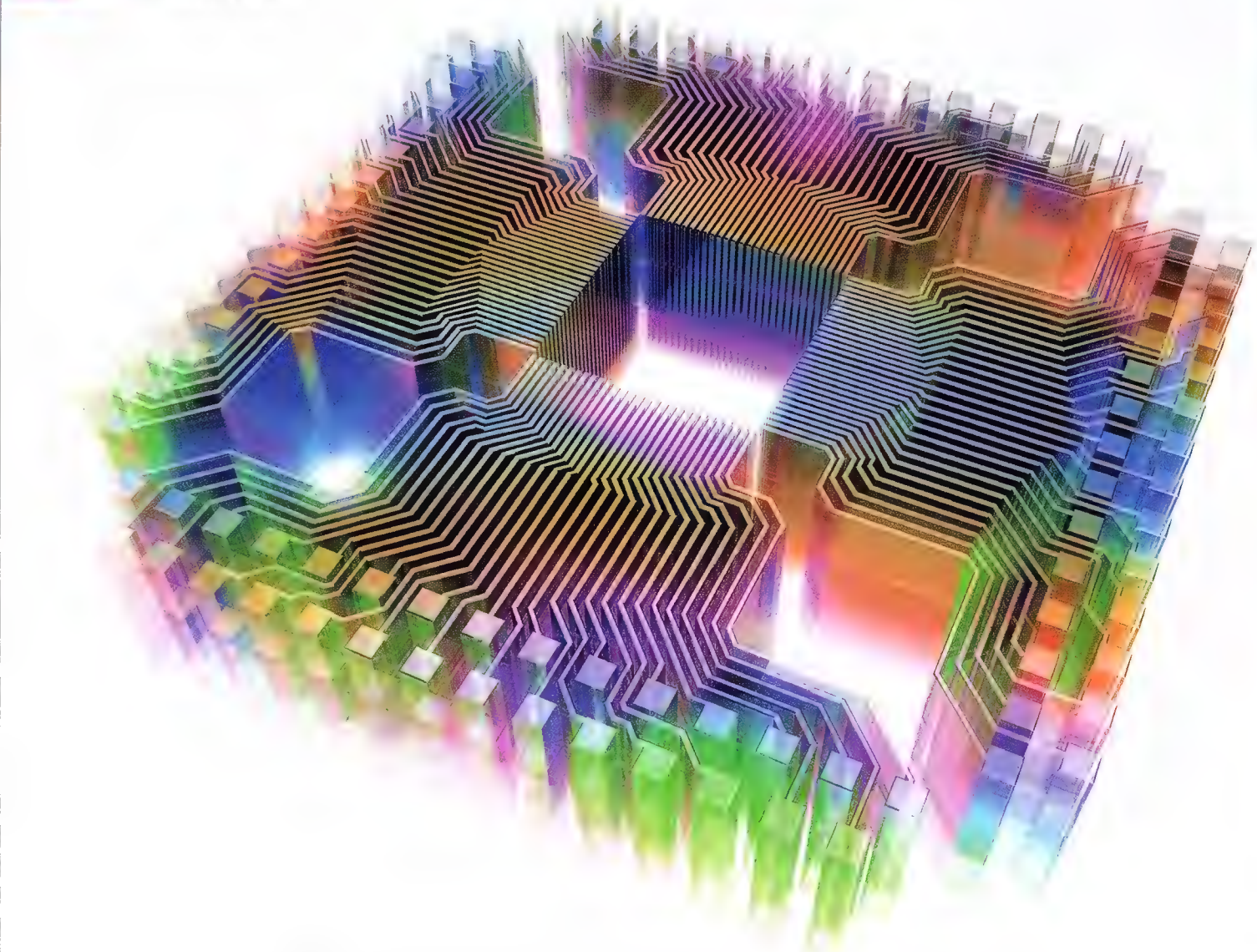
Companies either flagrantly misusing data or, at best, burying the details in legals of Tolstoyan girth, probably shouldn't come as news to anyone. With high-profile privacy news events like Cambridge Analytica and, further back, NSA spying, the concerns ought to be mainstream by now. So it's hard to get uppity, we've seen it all before, until you realise that the Internet of Things isn't just data stored on a server and it's not just your information buried away in a database: it's life, it's home appliances, it's heart rate monitors and it's, increasingly, public infrastructure. In other words, things that could be potentially wielded against the so-called 'customer' or 'owner' in fairly significant ways, not to mention the general public.

Watch Dogs is a popular video game series published by Ubisoft, which uses as one of its central puzzle-solving and war-waging tools the hacking of both public and private devices by hackers. The game won't win awards for subtlety, but it does contain at its heart a dilemma which is becoming increasingly worrisome in the 21st century: if our every move is traceable through data-capturing infrastructure and technology, are we really free? How can that data be used against us? Or worse still, are we delivering technologies that can cause disruption directly into the hands of hackers (and potentially terrorists), right on a silver platter? ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



Riding the quantum revolution

Mats Tage Axelsson introduces you to quantum computing, one of the strangest techs around. Learn how it works and how you can get started.

Quantum computing has caught the attention of large companies, academics and hobbyists alike. This article will cover the history, the different ways to make a quantum computer and the logic behind programming. You'll also learn about some programming toolkits that you can use to get started.

To run a quantum computer, the physics has to be understood so programmers can then manipulate and measure the final results. Scientists have observed quantum effects in photons, electrons and isotopes of many materials. This means engineers use superconducting materials such as niobium and aluminium to construct workable quantum computing systems.

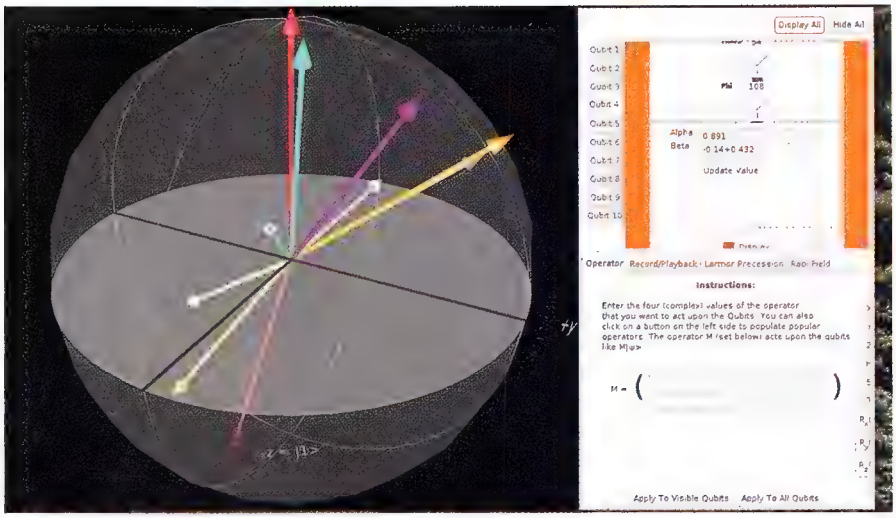
The logic gates are made of silicon wafers and are controlled using microwave emitters. These solutions may not be the best in the long run, but they're the ones that are running now. To use quantum computers, you need logic that takes advantage of the two core concepts: superposition and entanglement. When you start exploring these concepts, the Bloch sphere will help visualise what to do with different gates. Programmers can use classical bit gates together with quantum gates to create the algorithms needed.

The media hails quantum computers as significantly faster than current models. It turns out they're only fast in specific areas: simulation, cryptography, optimisation and database searches. In cryptography, many algorithms are safe because factorising large prime numbers with classical computers will take far too long for practical use. Shor's quantum algorithm can do it in minutes. Optimisation and simulations can benefit from a quantum computer's ability to test many solutions at once. Database searches are faster by a factor of four. And with faster database searches, machine learning also becomes much faster.

Image credit: Getty images

The history of quantum computers begins with quantum physics. In 1900, Max Planck first proposed that light comes in discrete packets called quanta. This discovery later led Einstein to show that Planck was right. When measuring the photoelectric effect, scientists could observe packet behaviour. These two discoveries later led to quantum physics. Yet, the deeper scientists dove into the quantum nature of things, the harder it got to explain how it works. For quantum computing, the most interesting developments are entanglement and superposition.

Superposition is the phenomenon where a particle exists in many positions at the same time. Considering this, scientists concluded that a quantum computer should be possible to build. A quantum computer is one that can do many calculations per operation.


Display All
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Beta -0.14+0.432
Update Value
Operator Record/Playback Larmor Precession Rabi Field
Instructions:
Enter the four (complex) values of the operator that you want to act upon the Qubits. You can also click on a button on the left side to populate popular operators. The operator M (set below) acts upon the qubits like M|ψ>
M =
Apply To Visible Qubits
Apply To All Qubits

Programmers use the Bloch sphere to illustrate how quantum gates manipulate the qubits.

> "The process is random, so observers won't know if the cat is dead or alive until they open the box. In quantum physics, the cat is both alive and dead."

THE CAT IN THE BOX

The famous physicist Schrödinger created a thought experiment. In it, he describes a cat and a gas container inside a box. The gas will poison the cat after the radioactive decay of an atom that releases the gas. The process is random so observers won't know if the cat is dead or alive until they open the box. In quantum physics, this means that the cat is both alive and dead before anyone observes it. In the case of the cat, this is absurd, but in quantum physics, it's normal. What Schrödinger was saying was that there must be another explanation — one as yet undiscovered.

Another phenomenon is entanglement, where two particles can have intertwined states. This means that the state of one particle will always be opposite of the other even when they are apart. In quantum computers, the software creates entanglement, a CNOT gate creates this state.

To make use of all the phenomena demonstrated in quantum physics, scientists needed a way to describe what happens on a small scale. To program a computer, it needs logical operations, described as logical gates. Quantum gates and classical logic gates are the same only up to a point. Quantum gates add features for changing states and entanglement.

It took until the 1970s for the first attempt at a theory to use quantum effects for computers. Shannon information theory describes classical gates and other aspects of data processing. For quantum computers, this is insufficient because it doesn't specifically describe quantum effects.

Quantum information theory was first attempted in 1976. During the 1980s, scientists made more progress, in part thanks to quantum computing conferences organised by MIT and IBM. Other interesting developments included quantum cryptography and the first universal quantum computer.

To make use of all the states of the particle you measure, programmers need a formal language. Quantum information theory needed to improve. The different gates are the foundation for such a scheme.

Keeping track of what the different quantum states are is confusing. First of all, the way it works is counter-intuitive at best. Second, there are many different spin axles to keep track of. The system isn't complicated, but it involves atypical approaches that are tricky to grasp. To make sense of all the state transitions, physicist created the Bloch sphere.

Peter Shor discovered Shor's Algorithm in 1994. This algorithm solves the problem of finding the prime factors of large numbers. The basis of all encryption is that you can't, in a reasonable time, solve this problem. Quantum computers may solve this problem in minutes. Interest in quantum computers subsequently sky-rocketed.

Shortly after Shor's discovery, Lov Grover invented the Grover algorithm. This is best known as the database search algorithm, but it's also

Encryption may be at risk

One big question is whether encryption systems are at risk with quantum computers. The major concern is the RSA encryption scheme. The scheme is secure because it relies on the condition that factoring a large number into its primes is too time-consuming. When trying to find the prime numbers, there are many strategies, so the simplest one is to guess and try. A trial and error approach isn't practical, though, since a 2,048-bit number will have millions of solutions. Some strategies can reduce the number of possible solutions, but even the most powerful methods will take years or millions of years. With the right algorithms, a quantum computer could reduce that time to a practical level. Efforts are underway to create other algorithms that aren't breakable this way.

While this is prudent, the risk that a quantum computer can do this within 15 years is low. The quantum computers that are available today are both small and hard to program. The frameworks available for programming are few and far between. As you can see in other parts of this article, you'll still be setting a few qubit states and twisting the states. Converting that to a fine-tuned encryption cracker is, more than likely, a far-off prospect for now.

useful for other tasks. Through the coming decades, scientists invented new features. Quantum error correction and fault-tolerant quantum computers were among the major ones. The first demonstration of a quantum computer took place in 1998. After this, development accelerated.

BOSE, EINSTEIN AND JOSEPH WALK INTO A BAR

To date, there is a range of quantum computers in use. Researchers are using ion traps, light-based and microwave controlled Bose-Einstein condensates. These types need different control mechanisms. The ion traps use an electromagnetic field to trap the ions. Lasers create the field and keep the ion trapped and to 'pump' the state of the electron of the ion. The electron will emit light only when the state matches the laser's frequency.

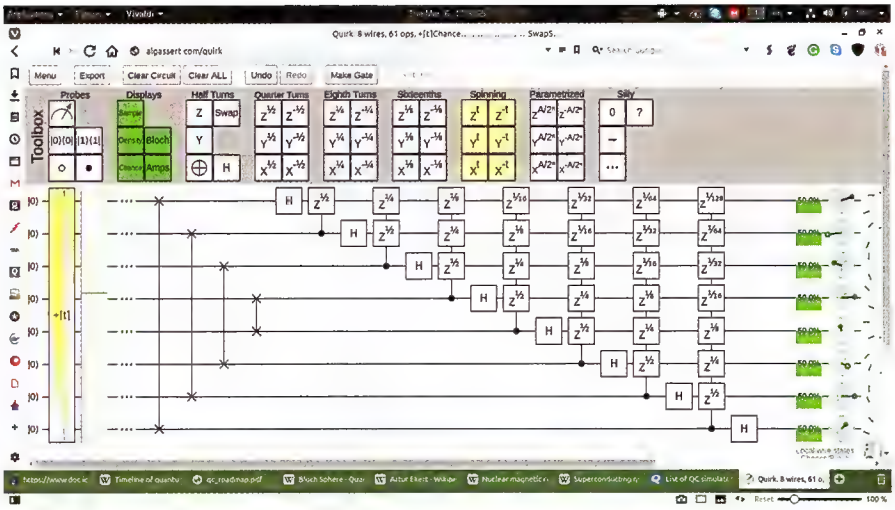
This is the logical 1 state, with the logical 0 state as the opposite. This makes it simple to measure, but achieving precision is still a challenge. Manufacturing is also expensive using current technologies. Meanwhile, a Bose-Einstein condensate is a gas cooled to millikelvin temperatures. When the gas reaches this temperature all electrons take the same quantum state. Uses for this solution are, so far, limited to simulators – any actual computers are pipe dreams.

The interesting types are the different Josephson junction types – these actually are running in practical setups. IBM's versions are even available for anyone who registers on the Q-experience web page.

D-wave's machine uses Josephson junctions. These are superconducting Niobium and aluminium-oxide gates. At temperatures near absolute zero, a SQUID measures their magnetic properties. A SQUID is a sensitive magnetometer. The values show the quantum state of the junction, making the circuit a qubit. The principle this computer uses is quantum annealing.

IBM's solution is Nuclear Magnetic Resonance (NMR). The qubit is still a Josephson gate. That solution uses microwave transmitters to interact with the qubit.

The difference between the two is that the IBM solution controls qubits to a higher degree. This has made it easier for Canadian company D-Wave to manufacture bigger chips. At the same time, this limits D-wave to fewer applications. For example, an annealing system can't run Shor's algorithm or Grover's. It's useful for optimisation and machine learning – no wonder Google already has one of its own D-wave quantum computers.



When starting out, programmers use a score, like a music score. The picture shows Quirk, an online simulator. The circuit is showing a Quantum Fourier transform.

> "In contrast, quantum computing involves all answers have a probability attached to them. No answer is certain – rather, it's probabilistic."

MORE IS LESS WORK

As mentioned earlier, the algorithms in quantum computers are different. To explain what the difference is, you must bear in mind the physics that are involved. As many *APC* readers will know, a conventional computer uses gates. The system uses Boolean logic to create the algorithms for calculating everything. The most important aspect of this is that it's deterministic, so we only deal in certainties. The answer is either yes or no – at least on the circuit level.

In contrast, quantum computing involves all answers having a probability attached to them. No answer is certain – rather, it is probabilistic. For this to be efficient the algorithms must be adapted accordingly.

Quantum gates have an effect on one or several qubits at a time. When you measure qubits, the system usually does a complete analysis of the entire system. So if you're searching for one qubit, that one will stick out like a sore thumb in one operation. Note that one operation is made up of many shots of the same gates. This is one of the reasons why quantum computers are faster than a conventional one.

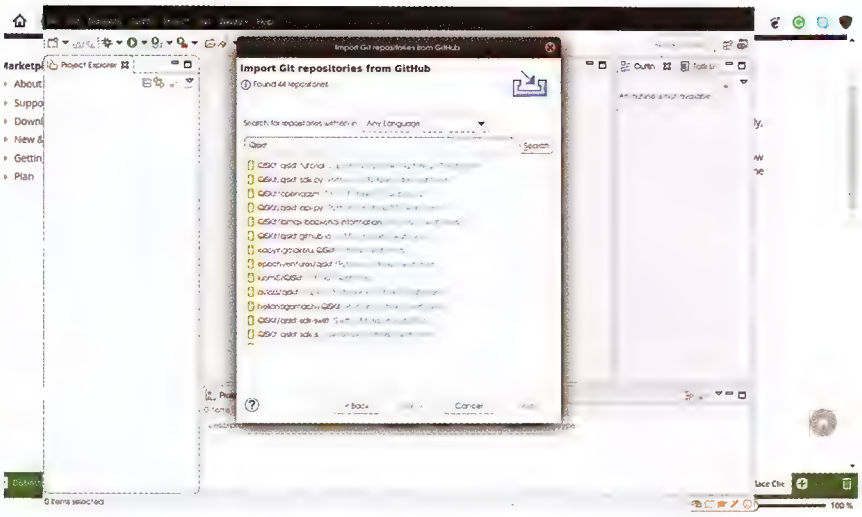
Quantum simulators

To help understand how quantum computers work, there are a large number of simulators. There's no way that you can simulate one efficiently, but if you want to understand the underlying principles then many of these are excellent. The first one that's worth exploring is a Bloch sphere simulator. Without having at least a rudimentary understanding of the Bloch sphere, you'll have trouble understanding what the gates do. Learn more about it at: **eecs.ceas.uc.edu/~cahaymm/blochsphere**

There are many more simulators — most of them are the results of PhD thesis work. For that reason, most of them are not active, only good starts. The few mentioned here are useful for self-education.

The JQuantum simulator looks and behaves like a quantum score. Using it is a little cumbersome, but if you're practising this while reading a textbook, then it becomes usable and clear. It also supports your own functions.

This is very useful when you follow a course and you want to test it out on your own. The only other way to achieve that is to use your IDE and write a quantum program yourself. If you have Python experience, this is doable, but be warned — the simulation won't look pretty!



Here, we're employing Eclipse to develop our own quantum computing programs. Note that this particular toolkit is using Python as the supporting programming language.

The most common scenario is to find the special number of many, such as a database search. The other most cited case is for breaking encryption. Using Shor's algorithm, you measure the solution by the action of the gates. The gates run the input a fixed number of times before finding the answer. That number doesn't change when the input is a higher number. A classical computer forces you to test all possible answers. This means that when the number reaches 2,048, you are facing a potential million years to solve it. More numbers mean an exponential workload increase. Note the difference is that the effort to solve the problem does not increase in a quantum computer.

LET'S HAVE A BLOCH PARTY

Once you know how many states and transitions you have in each qubit, it's time to code. Not so fast, though – there's a visual way to describe the gates. The Bloch sphere is the basis for all gates. The graph looks like a music score, so it's called a quantum score. It looks a bit different depending on the platform, but in general, the strings across are qubits. When you want to change the state of a qubit you place a gate on the string. To create entanglement between two qubits you drop the gate on one string and connect it to the other.

To describe the quantum state of a particle, you use spin, like a spinning ball. More precisely, the angle the 'ball' spins. Even though there are no balls that spin in the classical sense, the mathematics describe it well. When the equipment measures an electron, it'll be in spin up or spin down in one axis. The system can only measure in one dimension at a time. The three are x, y and z. So if you measure x, you lose all information about the spin state on the z- and y-axis.

When you describe the quantum state, you use an imaginary arrow in the Bloch sphere.

The top of the sphere represents the qubits logical 0 and the bottom is logical 1. These are the only two states that the system can measure with 100% certainty. To get a result in a quantum computer, you make many 'shots' and get the most probable answer.

A matrix contains the coordinates that show the arrows angle. The length of the arrow is always 1. The values we use to calculate the probability describe the components of the axes for the arrow. The Bloch sphere rules the gates and their naming, so keep that in mind when you try to understand.

The available gates depend on the application, and type of quantum computer. But the following are the common ones. The Pauli X Gate rotates the state around the x-axis changing the value of Z. This gate is also a bit-flip gate. The Pauli Y GATE rotates around the y-axis, changing both the x value and the z value. This gate is both a bit-flip and a phase-flip gate.

So far, the gates only flip the bits and phases. These don't deal with superposition or entanglement. The Hadamard gate puts the qubit in a superposition. To make that clear, the qubit will have a 50 percent chance of being 0 or 1, flipping between X and Z.

It will act like a dice, only using two in a row will always give the starting value. More gates that extend the Hadamard gate are S and its transformed conjugate.

To use entanglement, you use a CNOT gate, usually depicted with a plus sign in a circle and a line down to another qubit. The gate flips the target qubit when the control is 1.

Those are the basic gates that you'll encounter as you start out. On the IBM Q Experience, you have the opportunity to also create subroutines. A better idea, though, is to use a development kit. There are many kits available, and you can extend your IDE with them. Eclipse, Netbeans and Visual Studio have modules. They use several classical languages. The programming tools for Python, for example, are available from IBM. Note that the routines prepare scripts for the quantum computer – it doesn't run Python on it.

So get cracking. You won't create much at first, but you will have a lot of fun – we guarantee it! ■

Toolkits from the big guys

To program yourself requires the standard called OpenQASM. This is the basis for all development kits. Many groups have developed toolkits using this standard. The best known ones are from IBM, D-Wave and Microsoft.

IBM decided to use Python to create Qiskit, and you can download this kit from Github. It also has many sources and demonstration collections available. You can learn all about the current development state from there.

In both Eclipse and Netbeans, all you need to do is import the code into a project and explore. Don't forget to install Python 3.5 or higher before you try to compile. IBM's QE has these examples in their Python toolkit.

When you have the sources installed, you can only run simulations on your own computer. If you want to run on a real quantum computer, get an account on the IBM Q Experience. The setup is simple: all you need to do is open an account and get your API token from your account. Then copy it into the Qconfig.py file of the project you're working on. There's a credit system for using the real machines, so simulate until you're certain you've got it right. If you're really clever, you may be able to gain expertise level. In that case, you can obtain more units to run experiments.

If you're using Visual Studio, then you can download the Qvis file and add the extension. You still need Python support, though.

THE ORIGINS OF TODAY'S DRONES

Drones have taken off in the consumer space, but their roots are military. We take a look at this controversial area's past, present and future.

"Drones have flown into many professional and recreational areas in the last few years."

Thanks to a drop in manufacturing costs, and rapid advances in technology, drones have flown into many professional and recreational areas in the last few years. Drones are being used to help keep firefighters safe, assist rangers in spotting potential poachers, enable news gatherers to report from disaster zones, and keep maps up to date. There are also cinematographers who are using drones to replace traditional film-making equipment, enabling them to get shots that would be too dangerous and expensive to capture using a helicopter.

But it's not just the professionals who are using these devices. Drones are being embraced by non-pros, too, with the advent of drone racing and the impending invasion of throw-and-go flying cameras that will follow and film the users. Although the term 'drone' has been embraced by popular culture to apply to any unmanned flying device, there are many other terms and acronyms that are used to describe them – UAV (unmanned aerial vehicle), UAS (unmanned aerial system), RPA (remotely piloted aircraft), multi-rotor, as well as quad-, hexa- and octocopter.

But here, we'll be getting a valuable insight from a military drone pilot on how drones are being used in intelligence, surveillance, target acquisition and reconnaissance.

Fighting wars

Discover how UAVs are used to assist the military in the realms of Information, Surveillance, Target Acquisition and Reconnaissance (ISTAR).

The commercial and hobbyist unmanned aerial vehicles (UAVs) can trace their ancestors back to a military source. It was the military who were motivated to research and develop UAV technology, and who had the resources to do so. Some might trace UAVs back to the German-built V1 and V2 flying bombs of World War II, but these 'doodlebugs' were more akin to single-use missiles than today's remotely piloted UAVs.

The term 'drone' has traditionally been used to describe military UAVs. This military connotation has been a concern for some civilian UAV users who we interviewed. Craig Jump from Sky View Video explains: "One of the reasons I don't like to use the word 'drone' is because people think of military aircraft with the hellfire missiles on them." Jump also found that this military heritage can cause practical problems for civilian UAV users: "The technology is actually classified as dual use, which means it can be used as military technology. So, in certain countries, you need an export licence to take the kit there."

Despite their military heritage, many of today's drones are used for peaceful purposes, such as assisting firefighters in their assessment of an ongoing incident, or looking for refugees adrift in the ocean. However, the modern military still continue to deploy various drones in a range of offensive and defensive capacities. They are also a key driving force towards the ongoing evolution of drone technology. Although drones have been around for a few decades, recent technological developments have seen some dramatic changes, as Chris Cole from *Drone Wars UK* explains: "Since 2000, the combination of technological miniaturisation and wireless communication has been a real technological leap forward."

The term 'drone' has traditionally been used to describe military UAVs

Currently, most military drones are propellor driven, like their civilian multi-rotor and fixed-wing cousins, but that is set to change, as Cole explains: "The Reaper and Predator drones that we have now are comparable to the biplane. We are quickly heading towards faster, more sophisticated and stealthier drones with a low observable profile."

THE AUTONOMY DEBATE

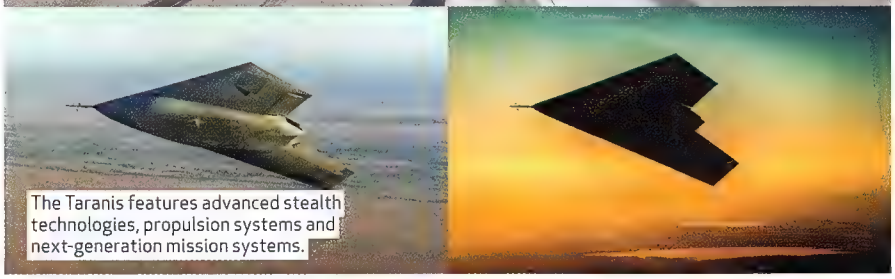
One advanced stealth drone is the Taranis – a demonstrator, delta-wing style UAV developed by British defence firm BAE Systems.

Unlike the flying bombs of World War II, modern UAVs are piloted, but have some autonomy. Civilian drones can be programmed to use GPS to follow way points on a map, so they can use their on-board camera to survey wide expanses of forest for wildlife, for example. As military drones can be armed with a deadlier payload, the issue of autonomy is a cause for concern, as Cole explains: "The big issue in terms of military drones is autonomous launching of weapons. There is a big campaign to stop that, and a lot of military people are very wary about moving from what they call having a 'man in the loop' to autonomy in the launching of weapons."

One of those men in the loop is Waqas Tariq, a drone pilot for the Nigerian Airforce: "Bigger UAVs are flown by three people: the mission commander, the pilot who is in control of the drone, and the payload operator who controls the gimble and cameras. 70% of fixed-wing UAV flying is autonomous, with 30% human involvement. Jobs like recording

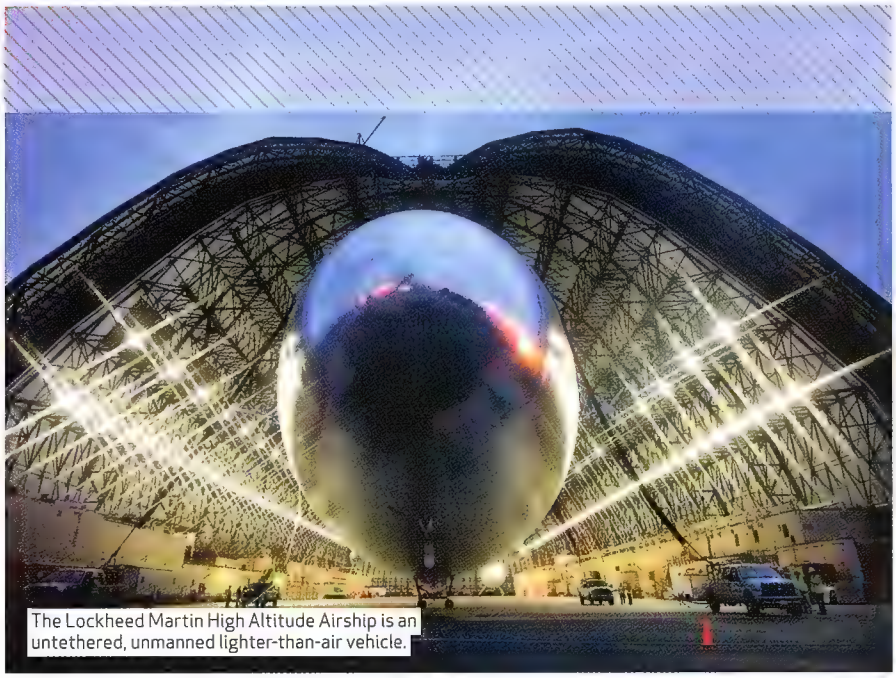
> "It was the military who were motivated to research and develop UAV technology, and who had the resources to do so."

The Boeing Phantom Ray is an American demonstration stealth unmanned combat air vehicle that is currently in development.



The Taranis features advanced stealth technologies, propulsion systems and next-generation mission systems.

© Boeing, BAE Systems, Ray Troll



The Lockheed Martin High Altitude Airship is an untethered, unmanned lighter-than-air vehicle.

the whole event and moving the cameras are carried out by humans. And obviously the human is the sole person who fires up a weapon on-board."

This 70% autonomy that Tariq mentions is extremely important, because it reduces the chances of human error in relation to keeping the drone safely in the air, where it belongs. Large, fixed-wing military drones can cost millions of dollars, with weapons costing hundreds of thousands of dollars. Chris Cole expands on the advantages of autonomy: "The difficulty is in the communication between the person on the ground and the person in the aircraft. If the aircraft is making decisions in terms of where to fly and how to sense and avoid obstacles, then that is safer, because communication between the pilot and the drone can get snagged or hacked if it isn't encrypted."

UAVs IN THE MILITARY

As a member of *Drone Wars UK*, Cole has been keen to monitor the various types of British military drones, as well as their uses: "In its armoury, the UK has the Black Hornet, a very small (five or six-inches long) rotor drone that you can put in your hand. It flies in and out of buildings, and sends a video feed. Then there's a lightweight, fixed-wing drone that soldiers just throw into the air.

"There are also a larger, fixed-wing drones called the ScanEagle and Watchkeeper. The ScanEagle is a prop-driven drone with a 10ft wingspan that can be catapulted into action by a launcher. The Watchkeeper is capable of flying over two hundred kilometres and sends video feedback to the army." As their names suggest, the drones Cole has listed are used for surveillance and reconnaissance purposes. Military drone pilot Waqas Tariq explains the advantage of using drones in this field: "The Nigerian Airforce uses the UAV in a much more efficient way, because the fighter jets are not able to fly for longer periods of time. But the UAVs can fly for 16 hours." Drones with more offensive capabilities are given more dramatic names, such as the Reaper. Cole tells us: "The Reaper is the armed drone for the RAF. The UK has ten of those in service and each can carry a payload of Hellfire missiles and GBU12 bombs."

Military drones have been around for decades, which is why people like Chris Cole feel compelled to keep asking questions regarding their usage: "Some people in the military accept the need for scrutiny. It's right that there are organisations like ourselves [*Drone Wars UK*] who are pushing people on this, as there are moral and ethical questions to ask." ■

Military drones

THE BLACK HORNET
As well as military reconnaissance, the Black Hornet can be used to safely inspect nuclear installations and chemical plants.

PD-100 BLACK HORNET
This is a nano air-surveillance vehicle that poses little risk to other vehicles or personnel due to its small size and light weight.

BLACK HORNET FLIGHT
The Black Hornet can fly for up to 25 minutes and navigate via GPS, or be manually controlled with the assistance of video feedback.

Thanks to a pneumatic SuperWedge catapult launcher, the ScanEagle can be deployed without needing a long runway, or from an unprepared site.

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HTC Vive Pro

Next-gen VR brings perfectly clear vision and a more comfortable headset, so now you can truly lose yourself in another world.

The HTC Vive has always been the leading virtual reality experience when it comes to room-scale immersion. Although rival headsets such as the Oculus Rift have since expanded to help you physically move around, and the PlayStation VR does it to a point, no other headset has quite been able to replicate what the Vive offers.

TECH ME ON

HTC is now launching the Vive Pro, an upgraded headset with higher-res displays and a more ergonomic design. On the tech side, there are two big changes. First is an increase in pixels, climbing to 2,880 x 1,600 (1,440 x 1,600 per eye) and representing a 78% increase from the original. Second is high-res audio headphones built into the headset. But after you've forked out the staggering $1,199, price you might be surprised as to what you actually get in the box: just the headset, the link box, a DisplayPort and USB cables for connecting the Vive Pro to your PC, a power adapter and the mounting pad for strapping down that link box. That's it.

To actually use the Vive Pro, HTC is expecting you to already own the pair of controllers and the two base stations required for tracking your movements. There is a bundle that gets you all of the necessary kit in one box, though, with two Vive 1.0 controllers and two 1.0 base stations for a total of $1,999 – a rather large investment.

ROOM WITH A VIEW

The good news is that the Vive Pro will work perfectly with your existing Vive kit, so it's just a matter of swapping out the headsets and link boxes to use in your VR space.

If you're new to the VR game, you need to prepare for what a faff it is getting everything set up properly. You have to download the drivers from the HTC Vive website, run the setup software and get everything plugged in. Then you must position the sensor units up high enough by balancing them on bookcases, tripods or screwing them into your walls; map the space that you want to use to play Vive Pro games; then finally run through the tutorial. That's before you factor in whether you'll need to clear extra space in your room to properly play. There's a standing-only option if you have a small space, but for the true Vive experience – one that makes it worth the big outlay – you'll need a space at least 2 x 1.5m.

For a lot of AU homes, keeping that much room clear on a regular basis isn't easy. And it doesn't help that, despite running the room setup several times over the course of testing, the software kept shifting our play space to the right, putting us in constant proximity to breakable things, such as our fish tank.

The tracking isn't always perfect, occasionally losing sight of one or both controllers mid-game. In fact, it's a little immersion-breaking when you're trying to take on a swarm of aliens in *Doom VFR*. Regardless of the complexity of the setup, there's nothing more rewarding in games than the virtual experience the Vive Pro has to offer when it's in full swing. The difference between the first Vive and the Pro is staggering.

EYE CANDY

The biggest upgrade is the improved sharpness. The twin OLED screens don't just deliver a higher-resolution experience overall (the original Vive's resolution

"There's nothing more rewarding in games than the virtual experience the Vive Pro has to offer when it's in full swing."

was 2,160 x 1,200 total), it also means that pixel density is increased by 37%.

The upshot is that having many more pixels in the same space means you can't see the individual dots anymore. The 'screen door effect', as it's known, was prevalent on the first Vive, the Oculus Rift and especially the PlayStation VR, which has a lower resolution than the other two. Seeing the pixels that make up the screen heavily detracts from the immersion you get from the games you're playing or the experiences you're having in VR. But that's all gone with the Vive Pro and it seriously changes the overall VR experience for the better, making it easier for you to forget that, in reality, you're still standing in your living room looking like an utter gronk, rather than, you know, actually being out there, surviving the wastelands in *Fallout 4 VR*.

That improvement in resolution and pixel density also makes text a lot easier to read and understand quickly. There's a distinct sharpness increase, which adds to the sense of immersion you get with in-game interfaces and any other times when you need to understand something on-screen.

The display refresh rate is 90Hz, the same as the original Vive. It's high enough to trick the eyes and avoid feeling artificial, though the PSVR is still the king with 120Hz.

LIGHTENING THE LOAD

Aside from the resolution boost, HTC has spent a lot of time refining the ergonomics. Technically, the Vive Pro is heavier than the original headset, and compared to the PSVR or Oculus Riftm it feels like a deadweight. But when you get it on your head, you quickly realise that the weight is better balanced and distributed, applying less pressure to your face. Thanks to a new rear headrest and a tightening mechanism on the back that's not dissimilar to the PSVR, the Vive Pro sits far more comfortably than the original Vive did.

The area that comes into direct contact with your nose has also been tweaked, reducing the amount of light that gets in; before this tweak, that pesky light would have reminded you that you're still in the world you tried to leave behind. The original Vive headset didn't come with headphones either, instead requiring you to plug in any you had to hand.

The new integrated headphones reduces the wires hanging around your body as you play, and makes the most of the spacial audio provided by the Vive Pro. Everything sounds beefy and detailed, and with a good 3D effect, contributing to a higher sense of immersion.

What's interesting, though, is that despite the fact that the website shows a man leaping about all over the place, this is still a tethered experience. HTC is releasing a Vive Wireless Adapter later this year, but it'll be an additional (as yet unknown) cost for Vive Pro owners. Even if you hold off buying the Vive Pro until the Wireless Adapter is released, it's unlikely to be thrown in for free. It's a seriously exciting and potentially game-changing solution if it works as well as HTC promises, but it's yet another costly upgrade.

POWERING UP

When it comes to a PC, you'll need to power a full Pro experience. HTC recommends using a rig packing at least 4GB of RAM, an Intel Core i5-4590/ AMD FX 8350 processor or better, and an Nvidia GeForce GTX 1060/AMD Radeon RX 480 or better. You can buy a suitable setup from about $1,000, though we'd recommend looking at around the $1,800 mark for something that will last a while.

That said, we tried the Vive Pro running off an Nvidia GeForce 980 Ti graphics card and it was fine, so you don't necessarily need to go with the latest-generation graphics if you've already got a solid PC.

With all of this in mind, the Vive Pro is an odd one for us to recommend at this stage. It's clear that it's the best immersive virtual experience you can buy; the clarity and detail is such a contrast to the original headset that it feels less like a Vive 1.5 upgrade rather than a visual overhaul, particularly for the big-budget VR release. But the timing and pricing feels off, what with the Wireless Adapter coming soon. Pre-orders around the world were selling rapidly, so there's clearly a demand for better-quality VR. For us, though, such a premium price should also include the Vive Wireless Adapter.

The HTC Vive Pro might offer the best VR experience on the market, but having such an large upfront cost of two grand for those coming to VR from scratch will make many baulk. Throw in the space and setup requirements and it's best to consider this an investment in the best VR experience. If you're happy to make that investment, we can recommend the Vive Pro.

For an easier setup and lower cost, the PlayStation VR is still the best option. And for a room-scale experience at a lower cost, the original Vive bundle is a good buy at $879. ■

Verdict

Features	★★★★½
Performance	★★★★☆
Value	★★½☆☆

The most immersive VR to date, with amazing screen upgrade and ergonomic headset. But that price...!

★★★½☆

apc HOT PRODUCT

NVME SSD

FROM $161 (250GB) | WWW.SAMSUNG.COM/AU

Samsung 970 Evo

Like a Charizard, this SSD is fully evolved.

For the last few years, Samsung's Evo family of NVMe solid-state drives have been ranked as the best SSD by us and many in the industry. Though these drives have never been the fastest, they're hardly the most expensive – putting them in a middle ground for flash storage that's five times faster than a typical SATA drive while still being affordable.

The prices of Samsung's NVMe drives have been going down steadily with each successive generation, and thankfully that trend continues with the 970 line.

Three years and an equal number of iterations later, the Samsung 970 Evo continues to hold on to that crown. With vastly quicker sequential write speeds, this is incredibly fast, even compared to most modern NVMe drives.

The Evo runs with the fastest sequential read speed of 3,500MB/s and sequential write speed of up to 2,500MB/s – dramatically faster than the 960 Evo's top-rated 3,200MB/s and 1,500MB/s sequential read and write speeds.

This is largely thanks to Samsung's mid-range drive adopting nearly the same 64-layer MLC V-NAND technology as its higher-end Pro brothers. Previously, the 960 Evo was built with a more affordable, but slower, form of TLC V-NAND. The updated Pro and Evo drives also share a newly designed Phoenix controller.

Topping that off, the Samsung solid-state drives also employ Intelligent TurboWrite technology to generate a large buffer of up to 78GB for even faster write speeds. With all of these improvements, Samsung claims the 970 Evo delivers 65% faster sequential write speeds.

Though it doesn't feature a fancy heat sink, like the Adata Gammix S11, Samsung does include Dynamic Thermal Guard technology to safeguard against overheating. The built-in hardware feature automatically monitors and maintains optimal operating temperatures, while a heat spreader and new nickel-coated controller further lower the SSD temperatures.

The Samsung 970 Evo's dramatically faster write speeds look impressive on paper, and in our testing, it proves to be as quick as it claims. The SSD actually peaks above its rated speeds despite us running the drive against our toughest Q-depth 32 CrystalDisk Mark benchmarks. All of the read and write speeds far outpace the 960 Evo – even the higher-end 960 Pro.

This, topped off with slightly higher random write speeds, enables the 970 Evo to transfer a 10GB file in nearly half the time compared to its predecessor. Folder transfers see an even greater improvement reducing the amount of time needed from 25.2 seconds to 12.64 seconds.

The Samsung 970 Evo also just barely edges out its competition, the WD Black PCIe SSD, with faster random reads and writes, sequential reads, as well as 10GB file and folder transfers.

Like a starter Pokémon, the Samsung 970 Evo has reached its full potential with its third evolution. Thanks to multiple improvements in the silicon, this drive reads and writes faster than ever before, can run for longer without overheating and is more affordable at large capacities.

For all these reasons, we've given the Samsung 970 Evo a perfect score and our Hot Product award.

Kevin Lee

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

The 970 Evo brings high-end performance in dramatic fashion while retaining its reasonable prices.

★★★★★

ALL-IN-ONE COMPUTER

FROM $7,299 | APPLE.COM/AU

Apple iMac Pro (Early 2018)

Extreme price, extreme power.

Apple has packed a workstation with up to an 18-core Xeon processor in a frame the exact size of the regular 5K iMac. The only thing more amazing than the engineering feat of producing it is the price you might pay for one.

Apple provided us with a very high-end unit for our review, but the 'basic' $7,299 model offers an eight-core, 3.2GHz Intel Xeon processor, a less-potent 8GB AMD Vega 56 graphics card, 32GB of memory, and a 1TB SSD. It's all hugely configurable – you are able to choose a 14-core processor (for an additional $2,560) or an 18-core option ($3,840). Going from 32GB of memory to 128GB costs $3,840... Customisations add up fast.

If you're wondering what the benefits are of spending that kind of money on a super-computer that fits behind a monitor, you can rule out the iMac Pro as being for you. To make it worthwhile, you probably have to be someone who looks at the price, calculates how much time it could save them, and then works out whether the two balance. Say, a video editor who sees the benefits from having multiple cores to render high-res footage and play it back in real time, or a programmer compiling code who could do with parallel computing output.

The reason this costs so much is that it's using workstation parts like ECC (error-correcting code) memory, which means your vitally important work is less likely to get corrupted and crash apps out, losing you time and money.

Obviously, it's fast. *Really* fast. Everything you do is effectively instant, though that's partly down to the storage, which is comically speedy. This is part of what makes it so good for video work. Its speed really stands out from other Macs once you start performing processor- or graphics-intensive tasks.

In our video export test in HandBrake, we found this Pro was three times faster than the regular 5K iMac! That's what we mean about the price being worthwhile if having this machine saves you a lot of time. When it comes to the computer's graphics, the Vega 64 chip in our review unit doubles the score of the 5K iMac in Unigine Heaven, but that's not real-world usage. The more important fact is that, if you want to play games in 4K or even 5K, you can, although not always super smoothly. This Mac is also powerful enough for VR content creation, which Apple is keen to push.

One thing that softens the price is that it's basically a workstation with a free 5K screen included. A stand-alone 5,120 x 2,880-pixel, 27-inch display that works over one Thunderbolt 3 cable will cost around $1,900, so getting it as part of the package here adds to the appeal. That said, it's the same panel you get in the regular 27-inch, non-Pro iMac. Still, the important thing is that the screen is totally gorgeous. It's bright, the colours are fantastically vibrant, and everything looks super-sharp.

You get four USB-A ports, an SDXC card reader, a 3.5mm jack, Ethernet port (with support for a 10Gbps connection) and four Thunderbolt 3 ports (which double as USB 3.1).

The iMac Pro does have one downside, though, which is that it's not rated for HDR.

Would we recommend the iMac Pro, then? Absolutely, but only if it really works out as being worth it for you – and only if you have the business accounts to calculate that. ■ **Matt Bolton**

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★

This new iMac is powerful and eye-wateringly expensive — it will appeal to a niche audience only.

★★★½

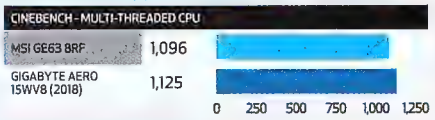
GAMING LAPTOP

$2,999 | AU.MSI.COM

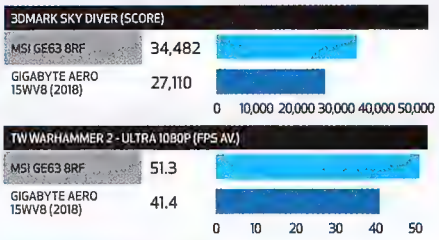
LABS BENCHMARK RESULTS

General performance

Media encoding performance



Gaming performance


3DMARK SKY DIVER (SCORE)
MSI GE63 8RF 34,482
GIGABYTE AERO 15WV8 (2018) 27,110
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TW WARHAMMER 2 - ULTRA 1080P (FPS AV.)
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GIGABYTE AERO 15WV8 (2018) 41.4
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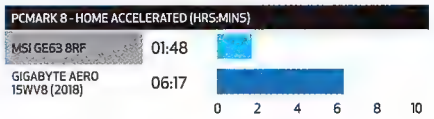
Battery life



MSI GE63 8RF-089AU

A new six-core CPU helps stimulate MSI's mainstream gaming laptop.

The GE line has traditionally been MSI's value gaming-laptop proposition – offering a well-rounded set of powerful components in a package that isn't cutting edge, but which also won't cost a fortune. This year's update keeps the tradition going with a minor price drop, CPU upgrade and some RGB lighting synchronisation. At 2.8cm thick, this range wedges itself into a gaming-specific size bracket with ample internal space for the device's 8th-gen Intel CPU, dedicated Nvidia GPU and 16GB of memory.

A 1080p 120Hz screen was the big new feature on last year's GE63, and the speedy screen's return is definitely still a highlight. Mind you, that screen doesn't have an ideal colour gamut for editing photos or working on design projects, at just 94% NTSC coverage, but its responsive nature is perfectly tailored to performance gaming.

On less demanding games, the GE63 8RF-089AU – MSI's higher-end GE63, with a GTX 1070 GPU – is easily capable of producing frame rates that utilise the faster screen, and it can even extend past 60fps on some of the latest titles (even on Ultra settings at times). You'll want to opt for the more powerful GTX 1070 GPU configuration.

The biggest change to this 2018 model is a new six-core Intel Core i7-8750H CPU, which adds two extra cores to the quad-core setup that's been the max we've seen on Intel laptops for over half a decade now. That means there's the potential for 50% performance boosts – and that's alongside any 8th-gen enhancements. Comparing this new GE63 8RF model against 2017's similar GE73 7RF on CineBench's single-core CPU test, we noted a decent 9% boost in performance, while the multi-threaded performance showed a far more impressive 49.7% increase. In general use tasks, this raw processing power translates to PCMark 10 scores at 20% better than the 2017 GE range.

Per-key RGB keyboard backlighting has returned, courtesy of MSI's ongoing SteelSeries partnership, but MSI has actually extended that functionality with its new 'GameSense' software. This allows you to match lighting schemes to specific in-game data points, like health levels or remaining ammunition, letting you turn your keyboard into an additional HUD. These neat perks are backed up by solid gaming performance, with the 3DMark Time Spy benchmark showing a respectable 10% boost over last year's GE73 7RF (which also sported a GTX 1070).

While the $2,999 price tag is quite competitive for a 15.6-inch laptop packing an 8th-gen Core i7 CPU and a GTX 1070 GPU, if that's too pricey, there's a GTX 1060 model (the 8RE) that's $300 less. The model we tested sported a 128GB SATA SSD and 1TB HDD storage combination, but both models sold in Australia will come with a bigger and faster 256GB NVMe SSD alongside that 1TB HDD.

If there's a weak spot in this unit, it's battery life, which left a lot to be desired. Lasting just 1 hour and 45 minutes for movie playback, you definitely won't want to leave home without the power brick. The chassis is also a little bulkier than we'd like, but that's par for the course with gaming laptops. Otherwise, though, the more powerful CPU and faster SSD help add a lot to what was already a well-balanced and reasonably-priced option. ■ **Joel Burgess**

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★½

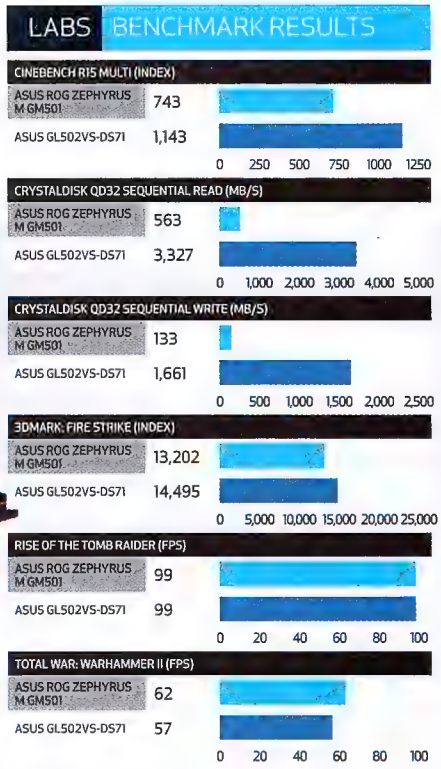
A balanced gaming configuration that is good on price, but suffers a little in terms of portability and battery life.

★★★★½

apc RECOMMENDS

GAMING LAPTOP

$3,599 | WWW.ASUS.COM/AU


LABS BENCHMARK RESULTS
CINEBENCH R15 MULTI (INDEX)
ASUS ROG ZEPHYRUS M GM501 743
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CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)
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ASUS GL502VS-DS71 1,661
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TOTAL WAR: WARHAMMER II (FPS)
ASUS ROG ZEPHYRUS M GM501 62
ASUS GL502VS-DS71 57
0 20 40 60 80 100

ASUS RoG Zephyrus M GM501

Six cores of pure gaming sizzle.

Six-core Intel CPU, Nvidia GTX 1070 graphics, IPS panel with 144Hz refresh and G-Sync support... On paper, ASUS's latest RoG gaming laptop has all the makings of a high-frame-rate portable powerhouse. But like any laptop, what matters is the detailed implementation.

ASUS says the thermal design of the chassis has been carefully tweaked since the previous model. The overall thickness is maintained, but the volumes have been optimised, and the number of thermal fin outlets has increased to four to improve heat dissipation. When the screen lid is lifted, a section of the chassis bottom levers open to raise the entire laptop by 9mm, which allows air to flow through the keyboard and maximise circulation. Nice. Speaking of the keyboard, it's fully RGB backlit, and offers 1.7mm of travel. Then there's the 15.6-inch 1080p LCD panel, with claimed 3ms response, and the high refresh and G-Sync capabilities, not to mention both a 512GB NVMe system drive and a 1TB SSHD for bulk storage.

What's more, ASUS reckons this new portable offers an improved balance between performance and endurance, thanks to a bigger battery and Nvidia Optimus, which switches between the Intel integrated graphics and the Nvidia GPU on the fly. Whether it's features or fine tuning, this thing has it in spades. But does that translate into a great experience?

The performance picture is mostly very impressive. ASUS has gone for the Core i7-8750H, one of Intel's new six-core beasts. Under heavy multithreaded CPU loads, and as fitted to this chassis, it'll run at around 3.9GHz for brief periods, before falling back to 3.3–3.4GHz during workloads such as sustained rendering. As for the Nvidia GTX 1070 GPU, we found it typically runs at just over 1,700MHz with occasional dips into the 1,600s. That's true even after a full hour of gaming. Given the desktop GTX 1070 chipset has a 1,733MHz maximum boost frequency, you're clearly not giving up much versus a desktop rig with similar components. The exception involves extreme combined CPU and GPU loads. That can see the CPU clocking back to 2.7GHz.

However, for gaming, it's unusual to see both GPU and CPU fully loaded at the same time. So ASUS has done a good job of managing the thermals, even if the area just above the keyboard does get very hot, and the fans kick out some serious noise under heavy loads.

Physically, this is a mostly pleasing portable, thanks to the high-quality chassis that uses plenty of metal, and a very solid keyboard. The downside involves the IPS LCD panel. The 144Hz refresh and G-Sync plus GTX 1070 graphics make for a slick gaming experience. That's especially true thanks to the 1080p native resolution. It's a good match for the GPU power on offer if very high framerates are the aim. But the panel itself isn't particularly punchy, and it's surrounded by an oversized bezel. This system is bulky for a 15-incher.

Battery life is another weak area. Despite being able to switch to integrated graphics, plus the larger 55Whr battery, you're looking at about 2.5–3 hours of video playback in practice. Long battery life isn't a core competence for this kind of portable, but given the emphasis ASUS has put on improving just that, it's disappointing.

Jeremy Laird

Verdict

Features	★★★★½
Performance	★★★★☆
Value	★★★½☆

With a great feature set and super all-around performance, only a few niggling caveats keep it from shining.

★★★★☆

FROM $3,696 | WWW.DELL.COM/EN-AU

Dell Latitude 5290

The 2-in-1 that might replace your business laptop... if you can afford it.

Now that 2018 is going to be another year without a new Surface Pro, Microsoft's competitors are putting out new top-of-the-line 2-in-1s with the idea of making 2018 their year instead. Enter the Dell Latitude 5290 laptop, a detachable device that the Texas manufacturer hopes will capture some of that 2-in-1 territory.

The Latitude follows the typical template: it has a deployable kickstand, so the tablet portion can stand on its own, along with a magnetised type cover for easy tablet/laptop conversion, and an extra-large bezel and tactile rear panel for easy gripping.

That said, the Latitude 5290 does bring some welcome wrinkles to the 2-in-1 blueprint. It has a nifty take on the kickstand – the leg auto-deploys by holding the tablet at a 90° angle and pressing it into a flat surface. Furthermore, the kickstand flexes a full 150°, allowing for custom viewing angles and easy access to the micro-SIM and microSD card slots, which are discreetly located around the back. It also boasts a Noble Wedge lock, smart card reader, NFC and a pair of DisplayPort over USB-C connectors. A magnet on the right side secures the Dell Active Pen (sold separately for $69) to the tablet, although the magnet isn't strong enough to survive a medium bump, so we recommend tethering the old-fashioned way.

Unfortunately, the 5290 also suffers from some of the same flaws inherent in all detachable devices. Non-flat surfaces will send your Latitude toppling unless it stays perfectly still. The screen is also a fingerprint magnet, despite the presence of anti-smudge technology.

The Latitude's 8th-gen Intel Core i5 processor helps it achieve excellent scores in our benchmark tests. Less exciting is its 8GB of DDR3 memory – that's only *just* enough – but the 256GB of PCIe NVMe storage is a solid amount of capacity and it's a quiet and fast drive.

With integrated graphics, the Latitude isn't trying to court the gamer crowd. It's a workhorse: it galloped through our benchmarks. It gets top marks for its vibrant display, too. The screen's sharp contrast and great viewing angles are real eye-savers.

However, there are a few areas where the 5290 fails to make the grade. Its battery only lasted 2 hours, 49 minutes. Dell suggests investing in its Power Bank Plus ($214) to extend the longevity away from power.

The Latitude's keyboard is not as dysfunctional as the battery, but its small keys and shallow levels of travel make long typing sessions difficult. The touchpad and touchscreen, by contrast, are intuitive and precise.

Even as detachable 2-in-1s go, the Latitude 5290 isn't cheap. But Dell's theory is that your business will pick up the tab because of this laptop's great value. In terms of performance and professionalism – a chintzy device it most certainly isn't – the Latitude delivers.

But is it comfortable to use? The keyboard is shallow, and its coolest feature – the detachability of the tablet – makes it unwieldy to use on non-flat surfaces. The Latitude isn't uncomfortable to use, then, but it could be more lap-friendly.

Anyone should consider the Latitude 5290. Even if it doesn't replace a traditional laptop, it's ideal for life on the road. ■

Verdict

Features	★★★★½
Performance	★★★★
Value	★★★½

Rugged, cool and well-equipped, only the Latitude 5290's limited battery life lets it down.

★★★★☆

apc HOT PRODUCT

ULTRAWIDE MONITOR

$1,699 | WWW.VIEWSONIC.COM/AU

ViewSonic VP3881

Shaking up the high-end super-wide 21:9 monitor segment.

Ever since the first 21:9-aspect monitor rolled out five or so years ago, the super-wide format has been about as polarising as it gets with flat panels. Some loved it for its cinematic sizzle, others trash-talked the limited vertical resolution and consequent poor productivity proposition.

Each successive generation has upped the ante in terms of vertical resolution. ViewSonic's VP3881 is a 38-inch monster with no fewer than 1,600 vertical pixels. Thanks to that 21:9 aspect, the horizontal count clocks in at 3,840. In other words, this is a 21:9 respin of the 3,840 x 2,160 standard – 4K or UHD.

However you slice it, the VP3881 packs a reasonable number of vertical pixels and, in turn, productivity chops for viewing docs. With this pixel grid, it's practical to view multiple documents side by side. Depending on your taste and comfort, as many as four is viable.

Of course, the VP3881 is not novel. In many ways, LG's 38UC99 and the VP3881 are dead ringers. Both sport the same 38-inch (37.5-inch viewable) diagonal, 3,840 x 1,600 native res, and are based on IPS panel tech. Both screens have identical 2,300mm curvature radii, and equally offer native 8-bit colour depth, with dithering up to 10-bit support. LG is one of the big players in the production of the panel itself, and we do indeed believe that it's one and the same LG panel found in both monitors. So it's surprising to note that ViewSonic's implementation is unambiguously superior.

For starters, it offers slightly wider colour spaces. For instance, LG claims 70% of the Adobe RGB gamut, while ViewSonic ups that to just over 75%. Even more significant, at first glance, is that ViewSonic is claiming HDR10 support. Dig deeper and you'll find that refers to the ability to decode HDR10 video, rather than fully support HDR10 rendering; a glance at the spec sheet reveals a maximum brightness of 300cd/m² – nowhere near the thousands of nits needed for true HDR playback.

All that said, the VP3881 is noticeably more vibrant and saturated than the relatively disappointing LG 38UC99. Black levels are also superior, with less evidence of the dreaded IPS glow that blights the LG. This is impressive, given the shared panel technology. ViewSonic has also bequeathed the VP3881 a high-quality enclosure and stand, plus good electronics.

The former includes a stand with wide-angle swivel support and 100mm VESA compatibility, not to mention understated but sleek styling. As for the electronics, it's packed with features. Admittedly, the OSD menu controls on the rear of the enclosure come with a learning curve, but after boning up, you'll find some useful features, including a wide range of colour space presets – such as sRGB, EBU, SMPTE-C, Rec. 709, and DICOM-SIM – the ability to toggle input lag modes and multiple levels of pixel response, and much, much more.

As for out-of-the box calibration, it's good to go for all but the most discerning pros. ViewSonic claims a Delta E below two for factory calibration, and all the scales and gradients look great to us, except for a little loss of detail in black tones. It ain't cheap, and the pixel pitch is, ultimately, nothing special, but that's an industry-wide issue for desktop screens.

Jeremy Laird

Verdict

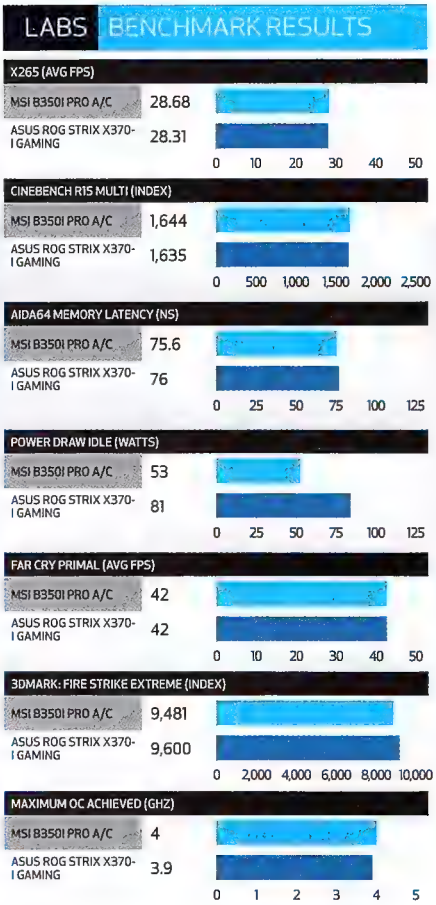
Features	★★★★½
Performance	★★★★½
Value	★★★★☆

While not quite as punchy as a true HDR panel, this is a genuinely useful pro monitor.

★★★★½

AMD 300-SERIES MOTHERBOARD

$169 | AU.MSI.COM


LABS BENCHMARK RESULTS
X265 (AVG FPS)
MSI B350I PRO A/C 28.68
ASUS ROG STRIX X370-I GAMING 28.31
0 10 20 30 40 50
CINEBENCH R15 MULTI (INDEX)
MSI B350I PRO A/C 1,644
ASUS ROG STRIX X370-I GAMING 1,635
0 500 1,000 1,500 2,000 2,500
AIDA64 MEMORY LATENCY (NS)
MSI B350I PRO A/C 75.6
ASUS ROG STRIX X370-I GAMING 76
0 25 50 75 100 125
POWER DRAW IDLE (WATTS)
MSI B350I PRO A/C 53
ASUS ROG STRIX X370-I GAMING 81
0 25 50 75 100 125
FAR CRY PRIMAL (AVG FPS)
MSI B350I PRO A/C 42
ASUS ROG STRIX X370-I GAMING 42
0 10 20 30 40 50
3DMARK: FIRE STRIKE EXTREME (INDEX)
MSI B350I PRO A/C 9,481
ASUS ROG STRIX X370-I GAMING 9,600
0 2,000 4,000 6,000 8,000 10,000
MAXIMUM OC ACHIEVED (GHZ)
MSI B350I PRO A/C 4
ASUS ROG STRIX X370-I GAMING 3.9
0 1 2 3 4 5

MSI B350i Pro AC

Budget buster beats the bosses.

An ITX Ryzen mobo, with a fantastic overclocking solution, and a kick-ass feature set, all on the B350 chipset. Wait, what? The understated brown PCB, the sub-high-end chipset, the simple, unsophisticated black heatsinks – it all mars an otherwise fantastic assembly of prime components designed to push the Ryzen ITX form factor to new heights.

What's so good about the B350i Pro AC? It all comes down to the power-phase design. There are nine phases in total here (with the closest competing ITX board housing a meager six in contrast), which helps provide the additional grunt needed to balance the power from a Ryzen core. At stock, the MSI B350i Pro topped our X265, Cinebench R15 Multi, Fry Render and AIDA64 memory latency scores across every first-gen Ryzen board we've tested by quite a margin. So much so, in fact, that we had to double-check our testing methodologies to make sure nothing was awry.

We've never seen anything like it. Generally, when you get these kind of scores in motherboard testing, the dead giveaway about what's going on is shown in the power draw figures. And, sure enough, peak draw testing puts the B350i Pro second highest, behind the Gigabyte AX370-Gaming 5, drawing a hefty 172W from the wall, compared to the AX370's 197W. There's not a huge difference between this and the other 'boards below it (about 4W at most), but it's enough to identify what's causing these higher figures at stock. And that's the stock Turbo performance.

Traditionally, Turbo clocks only kick in when a processor is under load. It's a smart way of saving power when the core's workload is non-existent. Under load, the processor ramps up the core frequency across all of its cores to the max safe operating parameters.

With Ryzen, AMD introduced a new form of Turbo tech known as XFR. Depending on the task at hand, and if temperatures are within the boundaries, it auto-overclocks and pushes as many cores as is needed to a higher frequency for better performance. So, you can get one core at 4.05GHz in demanding single-threaded applications, or eight cores at 3.9GHz in more challenging multi-threaded programs.

So if a mobo provides scores meaningfully higher than its competitors in our testing suite, it almost certainly means power draw is up (and it is, in this case), implying the 'board is leveraging temperatures and overclocks better than most. More often than not, because of that increased voltage, temps increase as well. But MSI has balanced this just right, to get more performance out of the processor without increasing temps much, with our tests reading around 65°C under load.

Unfortunately, all this VRM wizardry still doesn't translate to a higher maximum overclock (as the architecture is still fairly maxed out as it is), but it does mean that the B350i Pro is a fantastic, almost budget, ITX offering for those looking to get the most out of any Ryzen CPU without tinkering. Power draw is higher than we'd like to see, but not enough to worry us, as those temps are still within reasonable parameters. Connectivity is solid, too. There's nothing not to like about the B350i Pro, except perhaps the brown PCB.

Zak Storey

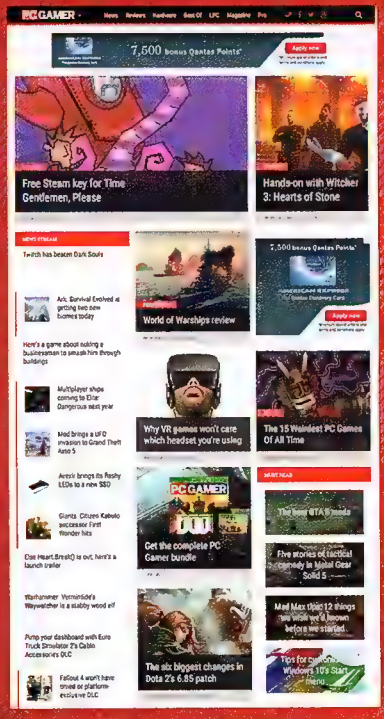
Verdict

Features ★★★★½
Performance ★★★★★
Value ★★★★½

Fantastic power solution with solid connectivity, good stock performance and an affordable price.

★★★★½

SMARTER COOKIES ENABLED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Apply now
Free Steam key for Time Gentlemen, Please
Hands-on with Witcher 3: Hearts of Stone
NEWS STREAM
Twitch has beacm Dark Souls
Ark: Survival Evolved is getting two new biomes today
World of Warships review
Here's a game about making a businessman to smash him through buildings
Multiplayer shoe coming to Elite: Dangerous next year
Mod brings a UFO invasion to Grand Theft Auto 5
Why VR games won't care which headset you're using
The 15 Weirdest PC Games Of All Time
Aerocool brings its flashy LEDs to a new SSD
Giants: Citizen Kabuto successor First Wonder hits
Get the complete PC Gamer bundle
Five stories of tactical comedy in Metal Gear Solid 5
Dax Heart.BreakIQ is out, here's a launch trailer
Warhammer Vermintide's Waywatcher is a stabby wood elf
Pimp your dashboard with Euro Truck Simulator 2's Cabin Accessories DLC
The six biggest changes in Dota 2's 6.85 patch
Fallout 4 won't have timed or platform-exclusive DLC

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WWW.PCGAMER.COM

BROADBAND ROUTER

$620 | WWW.DRAYTEK.COM.AU

DrayTek Vigor2862Vac

A DrayTek modem router with top-class wireless.

It's been a while since DrayTek last updated its line of small business DSL modem routers, but the new Vigor is a worthy update, modernising many of the features of the Vigor2860 series without departing dramatically from that baseline.

Aesthetically, the router is consistent with DrayTek's previous routers: no frills, with LAN, USB, WAN, DSL and phone ports up front for easy access. Only the power plugs into the back of the router. This isn't pretty when it's all plugged in – it's more like a rack mount in miniature than what you might have come to expect from more consumer-focused routers – but the DrayTek is designed to be practical, not pretty.

That approach extends to DrayTek's firmware itself, which is very powerful, giving you access to a lot of tools more commonly found in corporate routers. There are capable VPN tools with up to 32 simultaneous tunnels supported; it will support USB 3G/4G modems plugged into the USB ports with dynamic fail over in case of landline failure; it has corporate-grade content filtering and centralised management; smart monitoring and support for up to eight subnets and 1,022 IP addresses (most routers in this grade only support up to 256 devices).

DrayTek expects that somebody who knows what they are doing is at the helm of this device. There are no easy mobile apps and no pre-configuration. You will be expected to know your stuff, especially if you want to deep dive into some of the more advanced capabilities.

Compared to the Vigor 2860 line, the Vigor2862 series has received touch-ups across the board. The processor – previously 600MHz – now runs at 720MHz and the new router has twice as much memory. Perhaps the most significant change is to the wireless, which tackles one of the older DrayTek line's biggest shortcomings: the mediocre wireless performance.

The Vigor2862 now has an extra antenna, for a top speed of 1,733Mbps with 4x4 MIMO. It also now supports beam forming and multi-user MIMO, which makes it a Wave 2 router, in line with the best consumer wireless models. It also performed well when we tested it: at 5m from the router, we managed to get 59.9 MB/s download speed, and at 15m, we got 30.6 MB/s when tested with a 3x3 Linksys WUMC710 adapter/bridge. This compares well with the excellent TP-Link Archer VR2800, which received 63.9/27.4 MB/s in the same tests. DrayTek really has caught up when it comes to wireless.

Finally, there's the 'V' in Vigor2862Vac. That stands for 'voice', and DrayTek remains one of the few vendors that continues to build a VoIP system into its routers. With a VoIP setup, you can just plug one or two traditional phone handsets into the DrayTek, and have your calls automatically routed through a VoIP service provider – or, if the internet goes down, through a standard phone line.

There's a lot of depth in the VoIP settings, such as call forwarding, transfer and waiting, call barring and do not disturb, as well as an internal phone book. It's not nearly as capable as AVM's FritzBox! VoIP routers, but it's more than enough for most users.

While it's not a huge departure from previous models, it's fair to say that DrayTek has done all the right things with the new Vigor2862. Recommended.

Nathan Taylor

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★½

A very powerful small business router, fixing one of DrayTek's biggest weaknesses.

★★★★½

$259 | WWW.HYPERXGAMING.COM

HyperX Alloy Elite RGB

A robust but costly upgrade to a solid gaming 'board.

Nigh on 12 months ago, we took a look at the Alloy Elite and noted that this gaming keyboard's "feature innovation" rested solely on single-colour LEDs, media controls and a snap-on palmrest.

Zoom to now and we're cranking out this review on what is essentially the exact same board, but with flashier rainbow colours. And we're perfectly OK with that, thanks to how bloody well the Alloy Elite RGB is built. Weighing almost three packs of mince (1.47kg), the RGB's solid steel frame is fully up to the task of just sitting in the one spot on your desk. There's a generously large wrist rest that clips on the fore edge and keeps the overall ramp angle and typing position comfy. Just like the Elite before it, there's a trio of buttons on the upper left which gives you quick access to keyboard brightness, in-built lighting modes and a game mode which (as always) disables the Windows key and can save up to three custom profile settings. Over on the upper right is the traditional media bank including a deliciously ribbed volume scroller.

Apart from the rainbow of lighting colours now available, the second-most exciting new feature is the NGenuity software suite. It's light on system resource use and your go-to for personalising lighting zones and effects, creating key macros and assigning game presets and profiles. Our review unit was decked out in clicky Cherry MX Blue switches and is also available in speedy Red, tactile Brown and clacky Blue. Maybe next iteration we'll see our new favourite – Silver. ■ **Troy Coleman**

Verdict

A mostly cost-metic upgrade, in that you're paying extra for RGB colouring and a software toolset.

★★★★☆

$109 | WWW.HYPERXGAMING.COM

HyperX Pulsefire Surge RGB

Pretty and precise.

With this second mouse from HyperX, the rising star of gaming-peripherals has honed its focus while sprinkling on some welcome flourish. While the overall profile is flatter than the company's first mouse, the Pulsefire FPS, the generally pared-back design and matte-black aesthetic has remained much the same.

The most immediate addition to the Surge is its lighting capabilities, showcased by its 360° halo, which can be customised via HyperX's NGenuity software. The latter's intuitive and comprehensive, and also allows for the modification of DPI settings, button configurations (including ambidextrous support) and macro management. You can save up to three profiles to the on-board memory for on-the-fly adjustment. The customisation lets you tweak precise DPIs and configure specific lighting zones, if you desire.

While the previous Pulsefire FPS sported a Pixart 3310 optical sensor, the Surge has bumped it up to a newer 3389, which offers more than three times the resolution and a greater speed and acceleration profile. The primary Omron switches feel satisfying and responsive, as do the other three buttons. The 100g weight offers a nice balance between heft and zippiness, but the ability to customise this weight in some way would have inched it closer to being the perfect mid-range gaming mouse.

Overall, the Surge is a definite step up from its predecessor and it gives the big shots (like Razer's DeathAdder Chroma) a real run for their money. ■ **Harry Domanski**

Verdict

Sure to become a staple workhorse for PC gamers chasing stability and precision along with a lightshow.

★★★★½

GAMING HEADSET

$320 | WWW.ASUS.COM/AU

ASUS RoG Strix Fusion 500

A pricey headset for entire clans of competitive gamers.

ASUS has produced a few sets of Strix-branded headsets over the last couple of years, with this latest addition boasting "exclusive headset-to-headset RGB light synchronization" tech. Yes, like all 'gaming' branded things these days, they glow in a sparkling array of colours. The tech being spruiked here is the ability for multiple pairs of Fusions to sync their LED lights so that, according to ASUS, you and your friends can "crush the competition in perfect sync". As interesting as this feature might be, let's be honest... pulsating lights are probably not going to give you any competitive edge in gaming.

Luckily, it's not the only unique feature on offer. The cups sport a metallic-bronze finish, which is certainly eye-catching (if potentially divisive). The headset is solid in its build quality, with a sturdy design and comfortable cushioning on the headband. You can swap out the faux-leather cups for a set of plush material ones, too. The touch-sensitive controls on the left cup didn't impress, however. Tapping the centre of the cup initiated play/pause, which worked fine (albeit with a small delay); however, we had a lot of difficulty getting the next/previous (left and right) and volume (top and bottom) areas working smoothly. There are no physical bumps or grooves to help you locate the positions of these controls by touch alone, meaning it's easy to miss and, for example, turn the volume up by too many notches at once... with deafening results. You'll also need to be careful with how you take these cans off your head, as you may bump the touch controls while laying them down, as we did several times. Plus, once the protective sticker is removed from the glossy plates, it's fingerprint magnetastic. We'd honestly prefer some physical buttons or a wheel rather than this gimmicky system.

The Fusions connect via USB only – we would have liked the option of a 3.5mm audio jack or at least some wireless connectivity to broaden the use appeal here. While compatible with PS4, Xbox owners will need to look elsewhere.

But how do they sound? Virtual surround sound is, obviously, only a substitute for the real thing, but ASUS has done a great job of emulating the effect here. With a "hi-fi grade" ESS 9018 digital-to-analog converter and 9601 amplifier inside, the Fusion 500s do sound pretty good when you hit the surround switch on the left cup. Once on, you won't be turning it off. It makes everything from music to explosions much more meaty and the direction of certain sounds in-game is a lot easier to determine. With the option switched off, music especially sounds flat and unimpressive.

We've got no complaints about the retractable mic on the left cup – it provides clear voice recording and stows away neatly.

There are a lot of gaming models out there that similarly profess to offer 7.1 surround sound, so while the 500s do a great job, the fiddly controls, USB-only cable, plus lack of wireless and Xbox compatibility are all potential reasons you could be turned off. Then again, you may think all those caveats are worth the thumping sound that emanate from these cans' 50mm drivers and the LED synchronisation. If that's that case, they'll suit nicely... if you can afford them.

Carmel Sealey

Verdict

Features	★★★½☆
Performance	★★★½☆
Value	★★★★☆

Limited connectivity and gimmicky controls dampen what is very good virtual surround sound and solid design.

★★★☆☆

2.0 PC SPEAKER SET

$249 | WWW2.RAZER.COM/AU-EN

Razer Nommo Chroma

An unconventional pair of computer speakers.

If you're in the market for a new pair of computer speakers, there's a slim chance you'll find anything as cool as the Nommo Chromas – these stereo speakers with RGB underlighting take the boxy form factor we're used to and flip it on its head.

The result is a good-sounding pair of speakers that don't break the bank – the entry-level models, the Razer Nommos and the Razer Nommo Chromas only cost $169 and $249, respectively. If you're looking for a little more power, then the Nommo Pros add tweeters, a separate subwoofer and an inline remote (with AU pricing yet to be announced). The Goldilocks of the group, the Nommo Chromas, balance price and performance to deliver a very solid set of computer speakers.

The Chromas are dripping with Razer's distinctive aesthetic. The speakers themselves have a matte black plastic finish, and that's not even mentioning the RGB lighting that pulses underneath the speakers' stands – a fun, quirky addition that will be hated and loved in equal measure.

The lightshow can be controlled via the Synapse app, and helps set the speakers apart from the dull competition, plus you also get a digital-to-analogue converter (DAC) that boosts the sound from your PC media player of choice.

Above the glowing bases on the right speaker are two knobs – one that controls the volume and another that raises and lowers the amount of bass response. Around the back, you'll find a 3.5mm auxiliary input that enables you to connect your phone, tablet or MP3 player, as well as a headphone jack. You also get a cable that runs from the right speaker to the USB port on your computer – yes, sadly, it requires both power from the wall and the PC.

The biggest compromise of the design is that it doesn't feature Bluetooth, which would have made it easier to connect to some devices and reduce the clutter of cables that will now run amok on your workspace.

If you can get over the fact that there's some very clear catering to the bass-loving crowd here, the Nommo Chroma speakers actually sound great – good clarity in the mids and highs, and a powerful (if somewhat muddy) bass response that can cater to your tastes.

The first thing you'll notice when you start using the speakers is just how clear and concise that top end of the audio spectrum is. The trade-off is that the mids can get swallowed up in the process. Also, while the Chromas are bassy, we noticed a drop-off in the 60Hz range of the spectrum and then again in the 15,000Hz range.

All that being said, for watching TV shows and movies or playing games, these speakers sound absolutely fine. Sure, there are still some issues with voices not coming through as crystal clear as they should, but the speakers are more than capable of holding their own.

If traditional speakers aren't your style, then the Nommo Chromas are a set of well-designed alternatives. True, they fall flat in some areas of the audio spectrum, but spectacular clarity is a redeeming high-note for these stylish and very affordable computer speakers.

Are there better value sets out there? Sure. But if you're looking for easy-to-set-up speakers that require no extra work, you won't find any better than these.

Nick Pino

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★½

Aesthetically interesting speakers with exceptional clarity and nuanced mid-tones, plus pretty lights.

★★★★½

software

» APPS FOR ALL THE PLATFORMS

Windows SOFTWARE

CyberLink Screen Recorder 3 Deluxe

Recording, streaming and editing in one package.

$69.99 | WWW.CYBERLINK.COM

CyberLink Screen Recorder 3 (SR3) is clear and straightforward, even for total beginners, but at the same time is also surprisingly powerful once you drill into the more advanced options.

There's no shortage of premium screen recording and streaming apps for serious gamers and vloggers, but until now, there's been a substantial gap between these expensive programs and their free alternatives, which often apply watermarks to your videos or impose time limits, and lack advanced features like picture-in-picture. SR3 gets the basics right, making it easy to capture your entire screen, a specific app (useful for presentations and video tutorials) or a custom area. Moreover, you can also record games with hardware acceleration, or capture video from a connected device like a webcam – all with a couple of clicks.

Going beyond just standard screen recording, SR3 even allows you to capture video at the original resolution (1080p, 720p or 480p) saving you from having to spend time resampling it with a separate video editor. It's also possible to set a time limit for your recording, which is particularly handy if you want to upload your video online and need to keep within certain parameters, or need to avoid making a particularly large file.

If you only need to capture recordings occasionally and don't need advanced features like picture-in-picture, then a free tool like OBS Studio (**obsproject.com**) might be enough, but for more regular users, CyberLink Screen Recorder 3 Deluxe is one of the most affordable and full-featured options.

Cat Ellis

Cyberlink PowerDirector 16

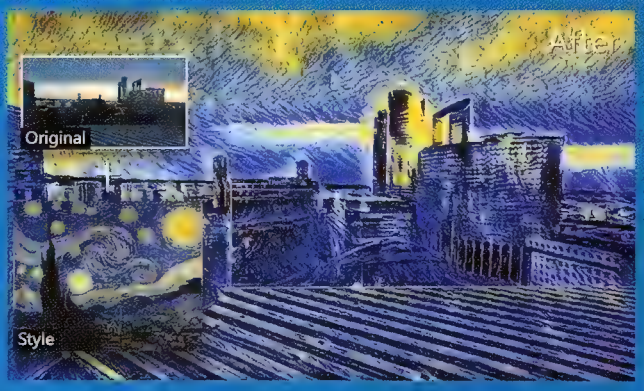
Advanced video editing made accessible and fun

$90 | WWW.CYBERLINK.COM

Video editing can be a complex, time-consuming process, but with Cyberlink PowerDirector 16, it's a task that's both easy and fun. That's not to say PowerDirector 16 is only suitable for beginners — on the contrary, it's a complete video production suite that's packed with the advanced tools you'd expect to find in industry-standard software. The difference is that these features are packaged in an intuitive interface, which lets you decide how much control you want, depending on your level of experience.

It's possible to make a good-looking video in seconds using the smart Magic Movie Wizard, or dive into the more conventional Timeline mode. You can go as deep as you want in any stage of the process, or let PowerDirector 16 automate it all.

The application's latest plugin uses machine learning to transform each frame of a video into a painted landscape.



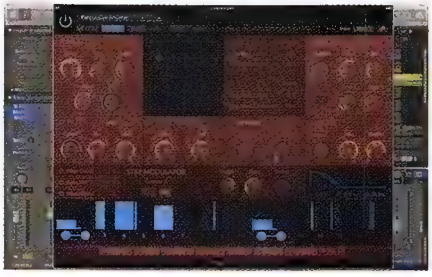
Using one of two styles generated from the works of Van Gogh or impressionist artists Claude Monet and Edouard Manet, the AI system can create an original 'moving painting' from supplied footage in resolutions up to 4K.

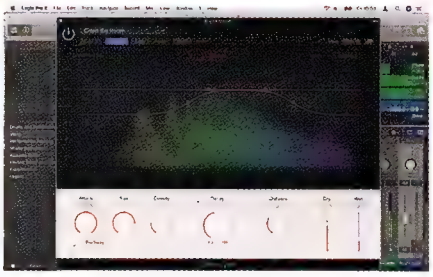
Cat Ellis

Logic Pro 10.4

Powerful music-making tool gets an upgrade.

FREE UPGRADE, OR $320
WWW.APPLE.COM/AU/LOGIC-PRO





Logic Pro 10.4 delivers significant new features, including automatic tempo detection. Instead of having to choose a tempo before you record, Logic can listen to you play and adjust the tempo accordingly. You can fine-tune its analysis and it copes admirably with subtle or dramatic tempo changes. It also works with imported audio, so it's easy to add extra instruments or automation to existing recordings, and you can create DJay Pro-style mixes by daisy-chaining files together ready for Logic to update their tempos.

It's a real boon to songwriters, because you can now record your performance before piling on other instruments and Drummer tracks. There are two new Drummers and two new brush kits. The two new virtual instruments — Studio Strings and Studio Horns — offer exceptionally realistic performance and extensive customisation.

The familiar Space Designer plugin has had a makeover and is joined by new plugins Chromaverb, Vintage EQ, Step FX and Phat FX. Chromaverb is a rebooted PlatinumVerb with a flexible algorithm that creates some interesting effects, although its real-time visuals don't work on older Macs. Vintage EQ is a lot of fun. There are three plugins: console, graphic and tube, and each delivers the warm output of classic hardware; the console EQ is modelled on the Neve preamps associated with classic rock.

Step FX and Phat FX are multi-FX plugins that enable you to chain effects together. In Phat FX, that means bandpass filtering, distortion, compression, LFO and limiting — in Step FX you can filter, delay, modulate, and edit individual steps. Phat is particularly good on bass drums and guitars, adding subtle warmth and extra kick, while Step offers a lot of fun with filters.

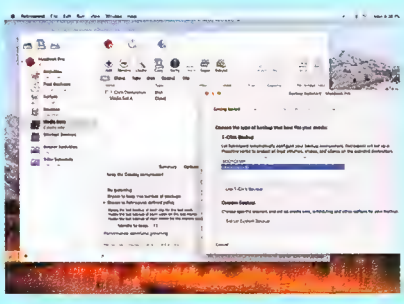
We're impressed that Apple decided to make these free for existing customers. If you aren't already using Logic, the 10.4 update makes an already superb music production studio even more compelling. While expensive for newcomers, Logic Pro 10.4 is a major upgrade with impressive new plugins.

Carrie Marshall

Retrospect Solo 15

Back up your Mac to more places.

FROM US$49 | RETROSPECT.COM



The release of Retrospect 15, which can back up your Mac to directly attached drives, networked storage and cloud services, includes a new edition. As the 'Solo' in its name suggests, it's the one to pick if you have just one Mac and want something better than Time Machine.

It uses the same interface as other versions, including the useful summary page, which confirms recent activity, how much data has been backed up, estimates the space you'll need this week and month, and more. Backup options are comprehensive, including two levels of file verification, password-protected encryption and catalogues you can search even when the corresponding media is unavailable. A highlight of this is email protection to back up the contents of IMAP-connected email accounts to local or other cloud storage. There's a wealth of help online, though getting familiar with this new system is inevitably more time consuming than with alternatives designed for consumers. Retrospect Solo 15 is a powerful and great tool if you're self-employed and can invest time in researching its many features.

Alan Stonebridge

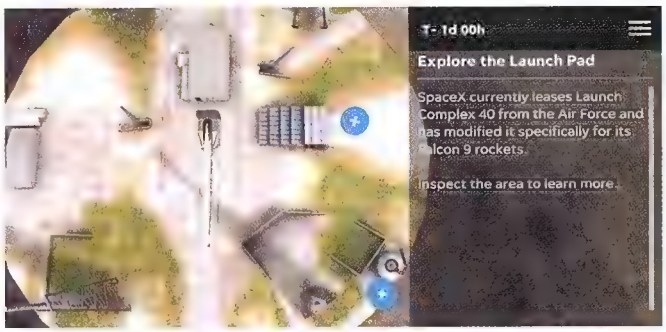
321 Launch

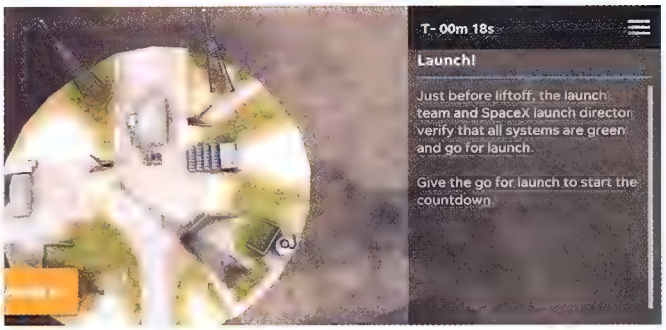
It's not rocket science any more.

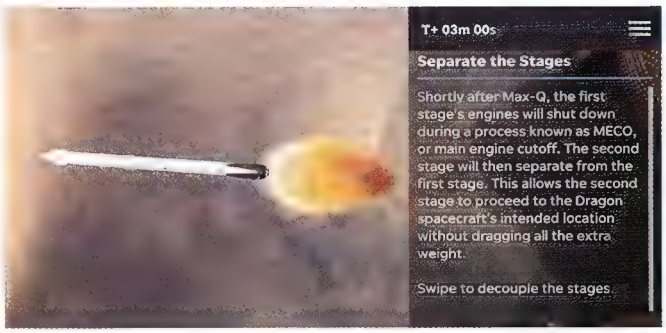
FREE | WWW.321LAUNCHAPP.COM

It's easy to be fascinated by the vast expanse that is the dark void beyond Earth's atmosphere, and one way to learn more about space exploration is via USA Today's new app. 321 Launch is an augmented reality app that walks you through building your own rocket and launching. You can even get a live feed to an actual launch when it happens.

The Launch Simulation part of the app is easy to use and well crafted. You'll need a flat surface to build your base station and then drag-and-drop virtual pieces to get it all together. Each step comes with its own narration and information panel, making it appropriate for all ages. Once assembled, hit the Launch button and watch your rocket take off amongst billowing clouds of smoke. It's an interesting and enjoyable experience. The Live Mission option on the homepage of the app gives you not just a live feed, but lets you swap to an AR experience, with live commentary straight from Cape Canaveral. **Sharmishta Sarkar**


T- 1d 00h
Explore the Launch Pad
SpaceX currently leases Launch Complex 40 from the Air Force and has modified it specifically for its Falcon 9 rockets.
Inspect the area to learn more.

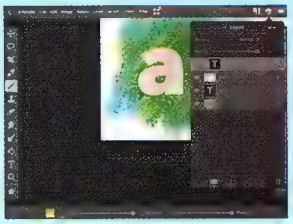

T- 00m 18s
Launch!
Just before liftoff, the launch team and SpaceX launch director verify that all systems are green and go for launch.
Give the go for launch to start the countdown.


T+ 03m 00s
Separate the Stages
Shortly after Max-Q, the first stage's engines will shut down during a process known as MECO, or main engine cutoff. The second stage will then separate from the first stage. This allows the second stage to proceed to the Dragon spacecraft's intended location without dragging all the extra weight.
Swipe to decouple the stages.

Artstudio Pro

Affordable painting app for iPads.

$17.99 | LUCKYCLAN.COM

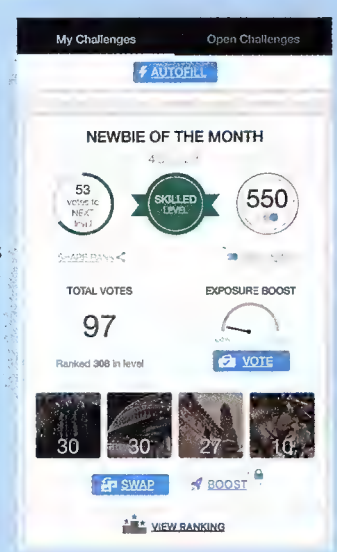


Artstudio Pro is a photo editor and a painting tool. The Adjust and Filters menus are reminiscent of Photoshop, there's a proper Layers palette, and the toolbox down the left-hand side includes image editing essentials such as selection Lasso, Clone Stamp, Sharpen, Dodge and Burn. Tap the paintbrush icon and you have a full range of inks, pencils, chalks and paints, which can be supplemented by importing brushes. Even better, the slider icon at the top right of the Brush Editor gives you detailed control over the look and behaviour of each brush, including dynamic response to pressure when you're using the Apple Pencil, or to velocity when painting with your finger. The results impress. There's also a Mac version ($62.99). Thanks to iCloud, you can make a new file at your desk and start painting, then pick up your iPad. The catch is that you have to export and import your custom brushes. We found the Mac-like design of the iPad version less than helpful, though. If you want one app for everything, don't need advanced retouching tools, and are prepared to learn an idiosyncratic interface, Artstudio Pro is decent value. **Adam Banks**

GuruShots

Up your photography game.

FREE WITH IAP | GURUSHOTS.COM



If you want a platform to hone your photography skills, GuruShots can help. The premise of the photography social site is to help budding talent learn by pitting themselves against each other in themed competitions. There are plenty to enter and each is proposed by an award-winning photographer, or Guru, who takes the time to mentor entrants. The app is easy to use. All new users are automatically entered into the Newbie of the Month competition and every vote your images receive increases your 'ability level'. You can gain followers, follow others and vote for your favourite images. The app is free but purchases can be made to help you get ahead in competitions. It's pretty much everything a photography social network really ought to be, and then some. **Sharmishta Sarkar**

Edge Action

Choice (short)cuts

FREE WITH IAP | TINYURL.COM/APC455-EDGE

Eyeing off the fancy Samsung Galaxy S9 with its fancy pants edge panel swipe system? Well, close your cycloptic eye, there's an app that'll achieve the same result – Edge Action. Simply swipe from the very edge of your Android's screen and a shortcut panel appears, overlaying the rest of your screen . It's actually seven shortcuts in one, from most frequent contacts to your favourite apps, quick tools, calendar and more.

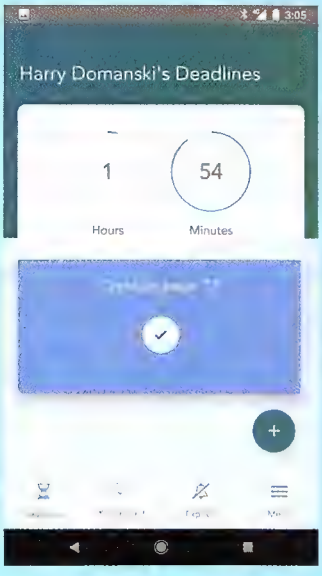
There are some superfluous functions in there, like the quick tools – Bluetooth toggle, airplane mode and so on – which you can find by swiping down from the top of your screen, and since there are seven shortcut panels, it's probably quicker to simply go into your app drawer and choose what you want from there. The free version is unobtrusive with ads limited to the settings menu, but you can remove them entirely for $3.09. You can also buy more shortcut pages to take screenshots and play music, but they seem totally frivolous. It's a lightweight, stylish app that offers functions from a high-end phone for zero dollars, so there's a lot to like. **Paul Taylor**

Timebound

Keep your deadlines from killing you.

FREE | TIMEBOUND.ORG

For those that manage multiple projects with multiple deadlines and find to-do lists a little too soft and unfocused, Timebound is a really neat solution. While it functions much like a calendar with reminders, the tidiness of the app's interface makes for an incredibly immediate experience for when you want to rapidly check in on the progress of your deadlines. You can either register an account with Timebound or log in via Google or Facebook in order to kick things off. Once you're in, creating and managing deadlines is very similar to Google's Calendar events — enter a title, date and time for your deadline, and then set up any notes or reminders you'd like for it along the way. The way they're displayed, however, is much more focused, with each project receiving a big countdown clock on the main page, and the other tabs allowing you to view completed or expired deadlines. Timebound will sync across any of your mobile devices and will adapt to different time zones so you can check on progress no matter where you are. **Harry Domanski**

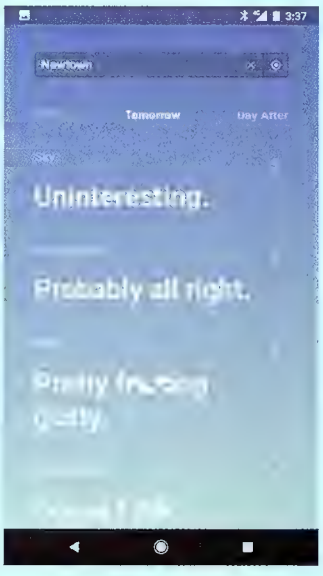


TFW (The F***ing Weather)

"The world's least accurate mobile weather experience."

FREE | ALCOHOLLICK.COM/TFW

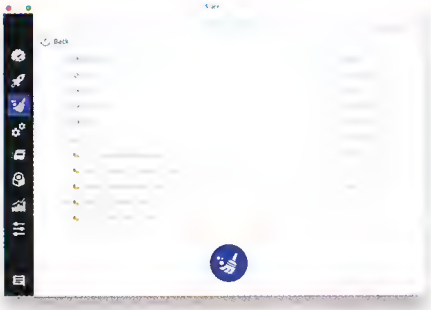
Are you sick of weather apps that pretend to give you hyper-accurate results? Tired of an alleged 7% chance of precipitation resulting in a downpour that floods your very soul? TFW aims to be "the most vague weather app available today", but in reality, it's a refreshing towel to the face of information saturation. The service uses data from openweathermap and then smooshes it down to some relatively vague statements about what the day's weather will look like in your area or an area of your choice. Expect such statements as "like the f***ing Sahara" when there's not much chance of rain, "pretty f***ing vanilla" if the temperature isn't especially hot or cold, and "enough wind to be s***" when there's enough wind... well, you get the idea. While there might not be an integrated widget, an option to save multiple locations, or even an in-app menu, the simplicity and brutality of this app is exactly what the market needs. **Harry Domanski**



Stacer

Clean up your system.

FREE | GITHUB.COM/OGUZHANINAN/STACER



The official project page says this is an optimiser for Ubuntu, but we managed to run and use it on a few other non Debian-based Linux system and it worked just fine. Stacer is a trendy Electron-based desktop program, which shares a similar design with Etcher, an ISO image flashing tool. Both use dark colours by default and offer the easy-to-install AppImage packages that make them portable. However, the modest USB flash tool is nearly 80MB and takes at least five second to start up, whereas the feature-packed Stacer is only 29MB large and starts noticeably faster.

Stacer's dashboard displays CPU, memory and hard disk usage, while a column of monochrome icons sit along the left edge of the window. Apart from the dashboard, there are six other sections that enable you to control your auto-start items, enable or disable Systemd-powered services, kill processes, manage installed software packages, and of course clean cache files and various sorts of system junk.

If your Linux distro doesn't use the Apt package manager, then Stacer won't be able to manage your software, and for Systemd luddites, the service manager feature will be missing as well.

The most interesting part of Stacer was its System Cleaner tool, which tackles package caches, crash reports, application logs and caches and the wastebasket. Cleaning application caches can be dangerous, because Stacer just wades through your dot files and by default wants to shred everything. That might not be ideal, so take care.

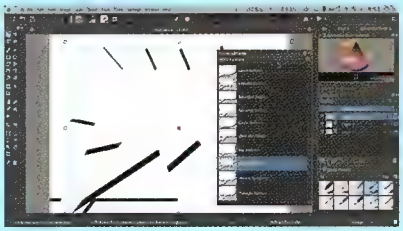
Thankfully, Stacer can be directed to only clean certain items, and taking this selective approach worked just fine.

Alexander Tolstoy

Krita

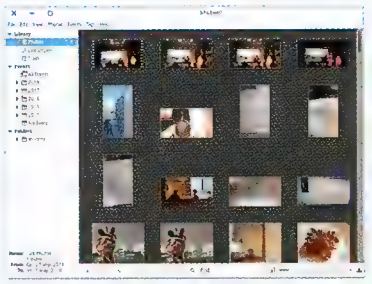
No longer a mere rival to Gimp.

FREE | WWW.KRITA.ORG



We've looked at Krita in previous issues, but a lot has been added to this app since then. Krita 4.0 is a bold release with plenty of new features. The program now has vector capabilities that sit alongside its usual bitmap image-editing tools. Furthermore, it's moved from the ODG format to SVG and has became fully compatible with Inkscape. That means you can copy and paste vector drawings and shapes between the two apps seamlessly. Krita enables you to fill and create outlines of any shape, select stroke width and style, join and intersect shapes, rotate and resize everything. So you no longer need a separate vector editor for basic vector drawing tasks.

Krita ships with some great sets of vector objects that are ideal for creating cartoons and comics production, and new tools for speeding up the process of colouring in comics. Elsewhere, the program's default brushes have been totally overhauled — and of course, you can create customised brushes, too. Krita 4.0 now integrates with G'MIC seemlessly, too, which grants users with access to dozens of artistic and creative layer effects. Getting the latest Krita release running is done via the Appimage package, available from the project's website. **Alexander Tolstoy**



Shotwell

Manage your photos.

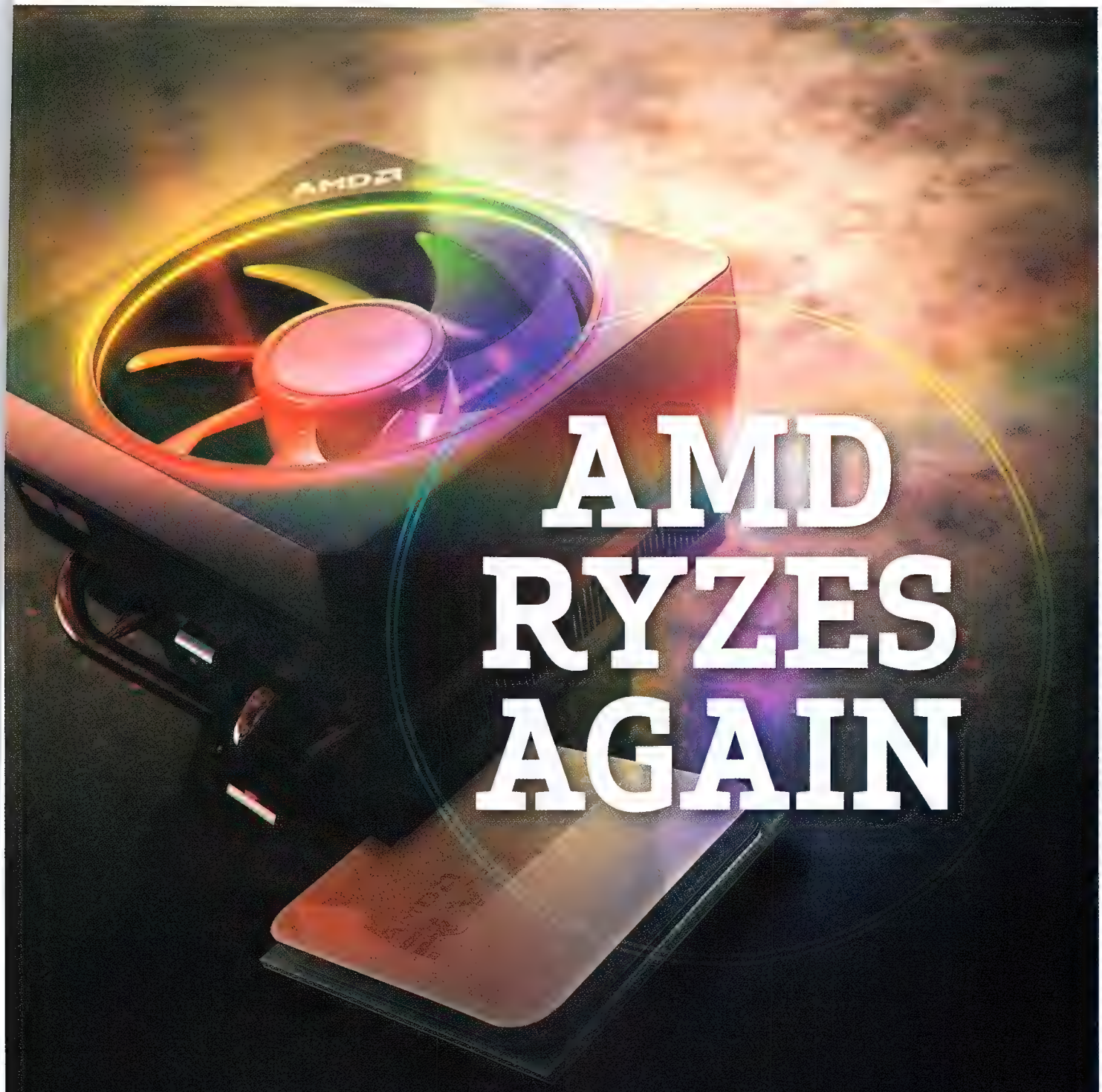
FREE | WIKI.GNOME.ORG/APPS/SHOTWELL

While it's hard to ignore the rapid development of Gnome's Photos, there's an even more powerful image-collection manager available. Not only does Shotwell fix over 60 bugs, the app now performs more efficiently. It sports a faster RAW import plug-in, better support for images with alpha-channel (transparency) and a new full-screen mode for the Shotwell image viewer.

Of course, the whole bundle is much more than just an image viewer. You'll appreciate the program's power features when it comes to importing shots from your camera or smartphone, especially if you want to arrange your files in date-based albums, add tags, events and rate your images using stars. All this extra metadata will come in handy as your image library grows.

Along with cataloguing features, Shotwell also has a simple image editor. It's no rival to Gimp, but still meets the modest needs of the average user. Select an image and use the buttons below it to rotate, crop, align horizon and remove red eye. A magic 'fix everything' button called Auto Correction won't be able to restore shadows and highlights, but it's good enough for simpler, auto levels-type adjustments.

Shotwell now supports the Meson build system — the one that the Gnome project recently moved to. However, you can build Shotwell with a classic sequence of `$ ./configure && make && sudo make install` . Unlike many other apps that depend on other bleeding-edge components that you might not possess, Shotwell is very tolerant and enables you to quickly build its code with very few dependencies. **Alexander Tolstoy**



AMD RYZES AGAIN

IT'S NOT QUITE ZEN 2, BUT AMD'S SECOND RYZEN INCARNATION STILL HAS A FEW ACES UP ITS SLEEVE. BENNETT RING TESTS THE NEW 2000-SERIES CPUS AND X470 MOTHERBOARDS.

It's not an understatement to say that AMD smashed it out of the park with 2017's release of the multi-headed Hydra that was the Ryzen CPU range. The company's long-term strategy of releasing CPUs with ever-more cores finally paid off, releasing six- and eight-cored beasts at the same price as Intel's quad-cored chips, dealing Intel a heavy blow when it came to applications that could make use of so many cores. Ryzen also added SMT, or Simultaneous Multithreading, a technology very similar to Intel's HyperThreading, allowing each core to handle two threads at once. Add in a very healthy improvement when it came to Instructions Per Cycle (IPC) compared to its last chips, and we finally had a CPU war raging once again.

While Intel still retained a slight lead in applications that weren't heavily threaded – which are currently still the norm, especially in games – AMD had a winner on its hands in multi-threaded apps. And it did so at a stellar price point, around half of what Intel was charging for comparable multi-threaded CPUs. Intel quickly lashed back with its 7th-generation Core CPU, doubling the number of cores while

SECOND-GENERATION RYZEN CPUS COMPARED

MODEL	CORES	THREADS	CLOCK SPEED MAX BOOST / BASE (GHZ)	SMART PREFETCH CACHE	TDP	INCLUDED COOLER	PRICE
RYZEN 5 2600	6	12	3.9 / 3.4	19MB	65W	WRAITH STEALTH	$279
RYZEN 5 2600X	6	12	4.2 / 3.6	19MB	95W	WRAITH SPIRE	$319
RYZEN 7 2700	8	16	4.1 / 3.2	20MB	65W	WRAITH SPIRE (LED)	$425
RYZEN 7 2700X	8	16	4.3 / 3.7	20MB	105W	WRAITH PRISM (LED)	$469

maintaining a decent IPC lead over the Ryzen, but by then, the cat was out of the bag. AMD motherboards supporting the new Ryzen processors arrived in droves, even though AMD's increase in CPU market share between 2016 and 2017 was only around 3%. However, that figure ignores the fact that people don't upgrade their PCs every year, indicating a strong uptake in AMD CPU purchases. Not one to rest on its laurels, AMD is releasing the second iteration of the Zen architecture that powers the Ryzen CPUs, known as Zen+.

"AMD had a winner on its hands in multi-threaded apps, and it did so at a stellar price point."

The two launch chips we'll be covering this issue are the Ryzen 5 2600X and Ryzen 7 2700X. At first glance, they might seem to be an incremental improvement on the first Ryzen chips, yet there are some deeper changes that make these new chips worthy of your consideration if you're yet to pull the Ryzen pin. Accompanying the second-generation Ryzen chips is also a new motherboard chipset in the form of the X470, which replaces last year's X370.

BUILDING A BETTER BASE

Before we delve into the specifics of the new CPUs, let's take a look at the new X470 chipset. Blessed be the engineers at AMD, as you don't actually need to upgrade to the X470 to take advantage of Zen+ CPUs. They'll quite happily play with last year's X370-based boards, just make sure it has the 'Ryzen Desktop 2000 Ready' moniker somewhere on its webpage or BIOS download site.

The X470 uses the same AM4 socket, a pin grid array layout AMD has been using for years. Yes, this means you'll have to be extra careful about not bending any pins on the bottom of your new CPU, but it also means you don't have to worry about bending pins inside the CPU socket, which can be even harder to straighten.

The easiest improvement to notice with the X470 is an apparent increase in the officially supported memory speed, from 2,666MHz to 2,999MHz. It's a little vague, though, with some 'boards claiming it as the norm, while others saying it's an overclocked speed. We also found the same memory speed glitch when testing these 'boards as the X370 – the twin 8GB G.Skill Sniper DDR4-3,444MHz memory modules that were supplied with our review kits usually defaulted to 2,133MHz when installed. To hit 2,999MHz required us to enter the BIOS to manually change the memory speed or switching to XMP mode. Having said that, once we'd done so, every 'board ran at 2,999MHz without a hitch.

The other major feature of the new X470 is what AMD is calling 'StoreMI' technology, a software solution that can even be purchased for X370 boards, for between US$20 and US$60, depending on how large you want your hybrid drive to be. It's akin to Intel's Optane technology, allowing your SSD to operate as a cache to your cranky old mechanical drive. Unfortunately, we didn't have time to test this out, but have heard rumours that it's compatible with Optane, which would be hilarious if true. AMD also claims that the X470 has a more refined power system, which should deliver better overclocking results, with many overclockers hitting 4.4GHz on all eight cores under load on the top of the line Ryzen 7 2700X (it usually operates at 3.7GHz when all eight cores are pushing data around). Other than that, though, this chipset seems to be business as usual, with the X470 being basically

AMD's stellar-priced Ryzen 5 2600X delivers great performance.

Stepping up to a Ryzen 7 2700X gives you a smidge more encoding power.

identical to its predecessor. So then, on to the more interesting business – the Zen+ architecture itself.

THE BIGGEST IMPROVEMENT IS THE SMALLEST

All of the new Ryzen CPUs are built on the same Zen+ architecture, so we're going to explain the basics for them before explaining how the four models differ. The biggest change to the Zen+ architecture is actually its smallest: that's to say that it has undergone a manufacturing process shrink, down from 14nm on the original Zen to 12nm, thanks to the folks at GlobalFoundries. This is smaller than Intel's existing 14nm+ process, and recent news suggests Intel won't hit 10nm until 2019 – a rather large delay from the initial claims that it would hit 10nm in 2015. This means that the Zen+ can scale to faster frequencies without requiring extra juice or heat; in fact, the entire Zen+ range has seen a 50mV reduction in core voltage at the same time as increasing in speed. Helping to keep these chips even chillier is a refined Integrated Heat Spreader, which uses a new indium alloy and die metallisation to deliver temperatures up to 10°C cooler than the first-generation Zen.

AMD has also paid attention to the Zen+'s IPC performance, although it's still lagging behind Intel in this regard. It does so through four enhancements, and cache performance is especially enhanced. According to AMD's specs, L1 cache latency has dropped by 13%, L2 by 34%, L3 by 16% and DRAM latency by 11%. There's even more meticulous power monitoring and delivery throughout the chip thanks to its 'Precision Boost 2' improvements with the result that, in ideal instances, all 16 threads on the new Ryzen 7 2600X can operate at the same frequency an original Ryzen CPU could manage on just two. Overall, these improvements combine to give the Zen+ a 3% IPC improvement when compared to the Zen design at the same clock speed.

FOUR TO THE FLOOR

AMD is initially launching four new Zen+ based CPUs, and the table (left) handily demonstrates how they differ. The amount of cache has increased, as have the frequencies. However, there is a trade-off despite the power improvements, with the 2700X's TDP increasing to 105W, up from the prior Ryzen 7's 1800X TDP of 95W. The good news is that all of the new Ryzens now come bundled with an air-cooled heatsink, and they're of a surprisingly high quality. We were very impressed at the volume levels of the Wraith Prism under heavy load, reaching just 44dB during the stressful conditions of Prime95's Small FFT Torture test. In other words, you're not going to hear even the hottest CPU once it's inside a case.

TO UPGRADE OR NOT TO UPGRADE?

If you're an existing owner of the first generation of Ryzen CPU, the incremental nature of the performance increase doesn't justify splashing out on a new Ryzen. However, they do offer performance that is comparable to Intel's CPUs at a more wallet-friendly cost when you consider they include cooling and an overall lower entry price. Unfortunately, our benchmarks don't really illustrate this performance parity, as they tend to focus on single-threaded performance (we sadly had to remove the HWBot benchmark due to ongoing issues with HPET timing and the Meltdown/Spectre fiasco). But we can confidently say that multi-threaded applications are rapidly becoming the norm, and its here that the new Ryzen shines.

If you're looking for the ultimate gaming beast, Intel is still the go-to guy in the room, but for most users, AMD's spiffy new Ryzen is a very compelling option indeed. Just remember that you're also going to need to buy a dedicated graphics card as, unlike AMD's APUs, the Ryzen CPU doesn't include an integrated GPU.

CPU BENCHMARKS

	AMD RYZEN 5 2600X	AMD RYZEN 7 2700X	AMD RYZEN 7 1800X	INTEL CORE I7-8700K
PRICE	$319	$469	$469	$499
PCMARK 8 – HOME (ACCELERATED)	4,901	5,035	4,883	5,215
CINEBENCH R15 - OPENGL (FPS)	109	135	116	161
CINEBENCH R15 - CPU (MULTI-THREADED)	1,384	1,756	1,625	1,418
CINEBENCH R15 - CPU (SINGLE-THREAD)	174	176	163	198
CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32T1)	543	559	544	560
CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32T1)	522	531	526	541
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)	18,687	20,387	17,887	21,464
FAR CRY PRIMAL (1080P AVERAGE FPS)	98	103	93	115

apc RECOMMENDS

$339 | WWW.ASROCK.COM

8 x SATA 6Gbps ports; 2 x M.2 PCIe x4; 8 x rear USB ports; ASRock Polychrome RGB lighting

ASRock X470 Taichi

Unbeatable price and performance.

Who says you need to blow the bank to have a good night out on the town (or sitting at your desk playing games)? ASRock has yet again upped the ante when it comes to value, with this exceptionally affordable motherboard keeping up with those that cost up to 30% more, in both performance and features.

There's no need to cover the physical PCIe lanes, as they're the same on every motherboard in this roundup. However, the top two x16 lanes have some of the sturdiest steel reinforcement we've seen; if only the twin M.2 slots were as well protected, as there's no heat-spreader for these thermally active little critters. This is the only 'board in the roundup to include eight SATA 3 ports, using an ASMedia ASM1061 chip to deliver the additional two over the X470's default of six.

We have to say we're fans of ASRock's recent aesthetic changes, with their Taichi range using coolers and print designs that look very steampunk thanks to the various cog-shaped appendages, such as the lower heatsink. Compared to other brands, ASRock has gone for a minimalist lighting design, with just a few light zones to accent key areas of the 'board. They're still fully RGB, though.

Wi-Fi is delivered thanks to an Intel solution, which mirrors the ASUS's external twin antennae on the rear I/O port and also delivers Bluetooth 4.2. The same company delivers the I211AT Gigabit Ethernet port. The 16-phase power design should deliver exceptionally ripple-free power to the CPU, but there aren't any on-board buttons to facilitate easier over-clocking. There is a clear CMOS button on the I/O panel, thankfully – a feature that we think every motherboard should now include. On the flipside, there aren't quite as many USB ports on the I/O panel as the likes of the ASUS, with eight in total, including a single Type-C. It also doesn't have quite as many fan headers as the ASUS 'board (right), nor are they as versatile. There's still more than most users will know what to do with, but if you want your PC to hover when it powers on, you'll need to look elsewhere for additional, more powerful fan connections.

Realtek doles out the decibel duties with its ALC1220 audio codec, and ASRock claims it has the same 120dB SNR DAC quality as more expensive boards. In other words, you don't need a discrete or external sound card unless you're a total audiophile.

A nice touch is the front panel USB Type-C connection, something that we're starting to see more cases support.

"This is the only board in the roundup to include eight SATA 3 ports."

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★★

The addition of a few extras gives this 'board the nudge it needs to get our entry-point recommendation.

★★★★½

apc RECOMMENDS

$469 | WWW.ASUS.COM/AU

10 x USB ports on rear I/O, including one Type-C; 5 x 3.5mm stereo minijacks for audio out; dual antennae connections; ASUS Aura lighting

ASUS RoG Crosshair VII Hero Wi-Fi

Ready, set, tweak!

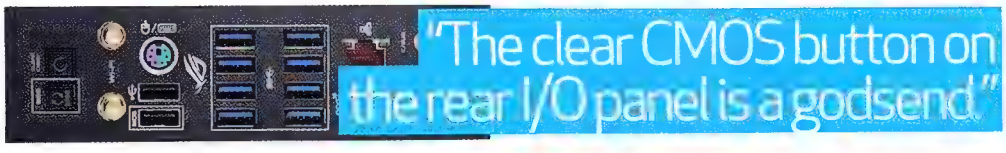
When we asked the Big Four motherboard manufacturers to supply their premium X470 motherboards for this roundup, we weren't quite expecting their submissions to be so, well, affordable. When we ask the same question regarding Intel 'boards, it's not uncommon to see slabs of silicon going for $700 or more. Yet at $469, and coming in as the most expensive X470 in our roundup, this ASUS motherboard is a prime example of why AMD is still seen as the bang-for-buck platform of choice.

You might expect it to come without the trimmings of a whiz-bang super premium 'board, but that's not the case. Everything you'd find on a much more expensive Intel-based mobo is present and intact. As an ATX 'board, it's got plenty of room for expansion ports, and uses the exact same layout as the other X470s in the roundup. There are two primary PCIe 3.0 x16 physical lanes, which can be split to run in x8/x8 mode for Nvidia SLI support, or stick with x16 mode for a single card. The bottom x16 lane only operates at PCIe 2.0 x4 mode, though, while the twin PCIe x1 physical lanes are limited to PCIe 2.0 x1 speeds.

As the name suggests, it comes with integrated Wi-Fi, with a twin transmitter/radio module that also brings Bluetooth 4.2 to the table. Even better, the Wi-Fi is also MU-MIMO compliant, making the most of those twin antennae. We're a little surprised that there's only six SATA 3 connections, though, as the cheaper ASRock 'board ships with two more, but at least it has two M.2 slots, one of which has a decent heatsink.

Overclockers will delight at the number of onboard buttons for tweaking; there's no need to short pins with your screw driver here. There's the usual power and reset buttons, but in addition, there are safe boot and retry buttons for when you've pushed an overclock that little bit too far. There's also a slow-mode slider for extreme overclocking, while the clear CMOS button on the rear I/O panel is a godsend. It's right next to the BIOS Flashback button, which allows you to update the BIOS without powering t he system up, something we had to do when our first flash failed.

Like most motherboards these days, ASUS uses Realtek's audio codec, but has beefed it up with a few changes, resulting in the slightly differently named S1220 chipset. As expected, it's got the usual 'best-in-class' audio capacitors, amplifiers and EMF shielding that every other maker claims. In reality, we could barely hear any difference in real life use.



"The clear CMOS button on the rear I/O panel is a godsend."

Verdict

Features	★★★★½
Performance	★★★★★
Value	★★★½

This 'board is overkill for your average gamer, but we're sure it's going to break a few overclocking world records.

★★★★½

$349 | WWW.GIGABYTE.COM.AU

6 x SATA 6Gbps; 2 x M.2; 10 x USB ports on I/O port; 11-phase power; Realtek ALC1220 codec; 802.11ac Wi-Fi

Gigabyte X470 Aorus Gaming 5 Wi-Fi

What a difference a number can make.

It's not easy buying a motherboard at the best of the times, what with them all promising almost identical features and claiming to all have the same benefits over each other. Things get even harder when you're trying to select between two 'boards made by the same company, in the same range, such as this one, which goes up against the X470 Aorus Gaming 7 Wi-Fi (right).

The obvious difference here is the price. At $100 cheaper than the Gaming 7, this is around a third cheaper than its big brother. So we can immediately assume that the hedge trimmers have been taken to this 'board. Looking at the specs on paper doesn't reveal too much of a difference, though. There's the same X470 chipset, three PCIe x16 physical lanes and twin PCIe x1 lanes. There's also two M.2 slots, though this time around, only one comes with a heavy-duty heatsink. This slight trim in cooling leads us to the cooling around the CPU power phases; in the case of this 'board, it's far more simplified than the 7. There's still a heatpipe, but it lacks the chunky aluminium fins that give the Gaming 7 such superior cooling. The physicality of the 'board isn't as imposing either. There's no backplate behind the CPU to provide superior rigidity, while only two of the three x16 lanes have steel reinforcement. LED lovers will also find that around half of the light zones of the Gaming 7 are now gone, with no lighting around the memory slots or right light panel.

This is in part because the Gaming 5 has an inferior power system, utilising an 11 phase (8+3) system compared to its big brother's 12-phase system. If you're not pushing your system, this won't make much of a difference, but it's a biggie for overclockers. Officially supported memory speeds have also been slightly cut, dropping from 3,600MHz to 3,200MHz, though in reality, this is really only a feature that benchmarkers will care about.

The I/O options have also been trimmed back, with a total of 10 USB ports but fewer of these are of the faster USB 3 standard, with four being USB 2.0. Aorus has seen fit to still include its power-tuning USB DAC-UP 2 ports, as well as a single Type-C port. There's no integrated I/O shield this time around, which isn't a biggie, especially when you consider this 'board still includes integrated 802.11ac Wi-Fi.

Despite these differences, at stock speeds, this board is basically identical in performance to the Gaming 7. It's the same story with the other 'boards; when you're all using the same base chipset, you're all going to perform nearly identically at default settings. It's like building a bunch of houses from the same bricks and mortar, but painting them differently – they'll all still weather the storm equally well. As such, the Gaming 5 is the perfect option for those who don't need the advanced overclocking features of the Gaming 7, and puts it neck and neck with the ASRock 'board, which has a slight edge in SATA connectivity.

Verdict

Features	★★★½
Performance	★★★★
Value	★★★★

Excellent value for money if you're not tweaking, though the ASRock has a very slight edge when it comes to features.

★★★½

apc RECOMMENDS

$449 | WWW.GIGABYTE.COM.AU

10 x USB ports; 802.11ac Wi-Fi; Intel Gigabit Ethernet; twin M.2 PCIe 3.0 x4 slots; extensive heat shielding

Gigabyte X470 Auros Gaming 7 Wi-Fi

The coolest kid around.

The first thing you'll notice when unpacking this motherboard is how damn heavy it is. Gigabyte has equipped it with arguably the finest air-cooled heatsinks of any X470 motherboard. An array of aluminium fins around the CPU's power components are connected via heatpipes, and are backed up by a thick steel plate behind the board. Both M.2 slots also come with heatsinks, and they're nice and chunky, unlike the slithers of aluminium often seen on other 'boards. The net result should be a 'board that can handle the additional heat pumped out by tweakers with a penchant for pumping up the power.

All three PCIe x16 lanes have sturdy steel reinforcements, and the top two include RGB lighting... along with the memory slots, I/O cover, right side light panel and bottom heatsink. 'I Wear My Sunglasses at Night' is a song that springs to mind when this 'board is fully powered up with all RGB zones cranked to full brightness. Given Gigabyte's overclocking pedigree, not to mention the price, we were a little disappointed at the scarcity of onboard tweaking buttons. There's just a single automatic overclock button, along with two BIOS sliders. One determines which BIOS to use, while the other is there to enable this feature, which seems rather unnecessary. Thankfully, there's a clear CMOS button on the rear I/O panel, alongside the 10 USB ports. You guessed it, one of these is Type C, but what you wouldn't have guessed is the two USB DAC-UP2 ports, a feature Gigabyte has worked on for some time now. These specialised USB ports deliver exceptionally clean power, making them perfect for external audio devices or USB peripherals that require large amounts of energy.

As is the norm, integrated Intel Wi-Fi is included; interestingly this chip also includes the all-new Bluetooth version 5, which supports lower energy usage, as well as playing two different audio sources on two different Bluetooth devices at the same time. Finally, it's twice the speed of Bluetooth 4.2, at up to 2Mbps, provided your device is approximately three millimetres away.

We would have liked a couple more SATA 3 ports than the six included for this price, but Gigabyte has instead poured its budget into the power components. It uses a 12-phase power delivery system for the CPU, and like all of the new X470 boards has a supplementary 4-pin CPU power connection next to the usual 8-pin plug. Gigabyte claims that the power system is as reliable as those seen in server motherboards, where 100% uptime is a must.

"There's just a single automatic overclock button, along with two BIOS sliders."

Verdict

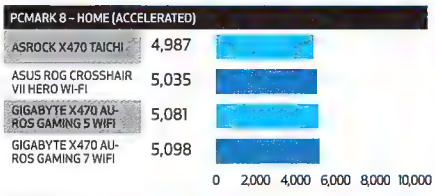
Features	★★★★½
Performance	★★★★★
Value	★★★★½

The slight price drop and additional cooling might be enough for overclockers to take a second look.

★★★★½

"It's not easy buying a motherboard at the best of times, what with them all promising almost identical features..."

LABS X470 MOTHERBOARD BENCHMARK RESULTS


PCMARK 8 - HOME (ACCELERATED)
ASROCK X470 TAICHI 4,987
ASUS ROG CROSSHAIR VII HERO WI-FI 5,035
GIGABYTE X470 AORUS GAMING 5 WIFI 5,081
GIGABYTE X470 AORUS GAMING 7 WIFI 5,098
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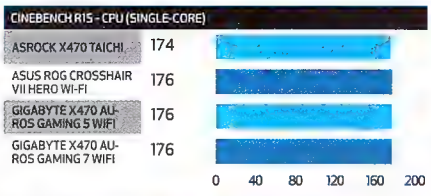
CINEBENCH R15 - CPU (SINGLE-CORE)
ASROCK X470 TAICHI 174
ASUS ROG CROSSHAIR VII HERO WI-FI 176
GIGABYTE X470 AORUS GAMING 5 WIFI 176
GIGABYTE X470 AORUS GAMING 7 WIFI 176
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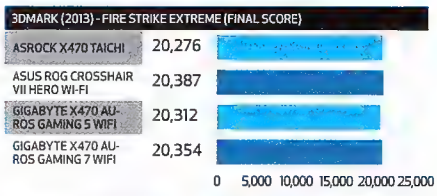
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)
ASROCK X470 TAICHI 20,276
ASUS ROG CROSSHAIR VII HERO WI-FI 20,387
GIGABYTE X470 AORUS GAMING 5 WIFI 20,312
GIGABYTE X470 AORUS GAMING 7 WIFI 20,354
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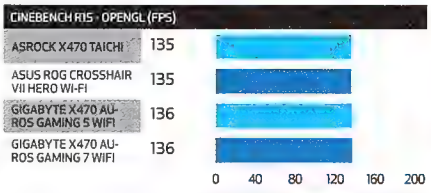
CINEBENCH R15 - OPENGL (FPS)
ASROCK X470 TAICHI 135
ASUS ROG CROSSHAIR VII HERO WI-FI 135
GIGABYTE X470 AORUS GAMING 5 WIFI 136
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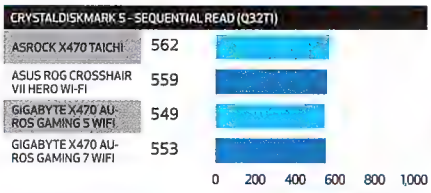
CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32T1)
ASROCK X470 TAICHI 562
ASUS ROG CROSSHAIR VII HERO WI-FI 559
GIGABYTE X470 AORUS GAMING 5 WIFI 549
GIGABYTE X470 AORUS GAMING 7 WIFI 553
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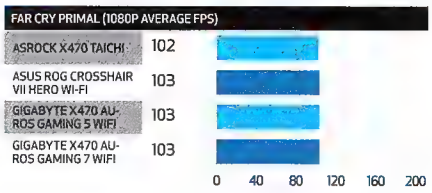
FAR CRY PRIMAL (1080P AVERAGE FPS)
ASROCK X470 TAICHI 102
ASUS ROG CROSSHAIR VII HERO WI-FI 103
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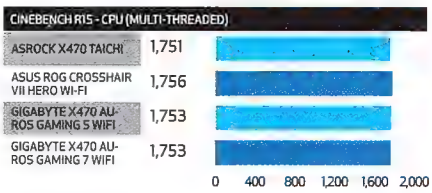
CINEBENCH R15 - CPU (MULTI-THREADED)
ASROCK X470 TAICHI 1,751
ASUS ROG CROSSHAIR VII HERO WI-FI 1,756
GIGABYTE X470 AORUS GAMING 5 WIFI 1,753
GIGABYTE X470 AORUS GAMING 7 WIFI 1,753
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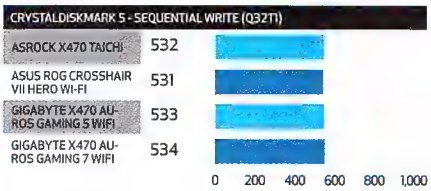
CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32T1)
ASROCK X470 TAICHI 532
ASUS ROG CROSSHAIR VII HERO WI-FI 531
GIGABYTE X470 AORUS GAMING 5 WIFI 533
GIGABYTE X470 AORUS GAMING 7 WIFI 534
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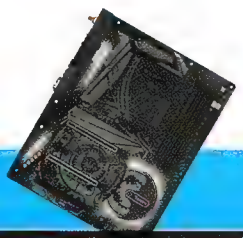

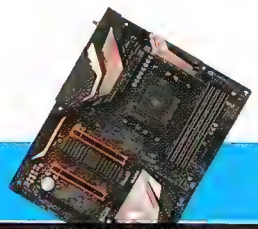

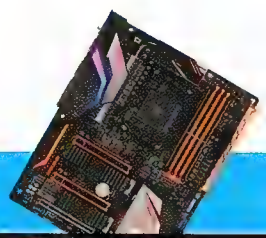

MOTHERBOARD SPECIFICATIONS

	ASROCK X470 TAICHI	ASUS ROG CROSSHAIR VII HERO WI-FI	GIGABYTE X470 AORUS GAMING 5 WI-FI	GIGABYTE X470 AORUS GAMING 7 WI-FI
SATA 6GBPS PORTS	8	6	6	6
M.2 STORAGE PORTS	2	2	2	2
EXPANSION SLOTS	3 x PCIe x16; 2 x PCIe x1	3 x PCIe x16; 2 x PCIe x1	3 x PCIe x16; 2 x PCIe x1	3 x PCIe x16; 2 x PCIe x1
AUDIO CHIPSET	REALTEK ALC1220	ASUS S1220	REALTEK ALC1220	REALTEK ALC1220
WI-FI	YES	YES	YES	YES
ETHERNET	INTEL I211-AT	INTEL I211-AT	INTEL I211-AT	INTEL I211-AT

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RASPBERRY PI ROBOTS

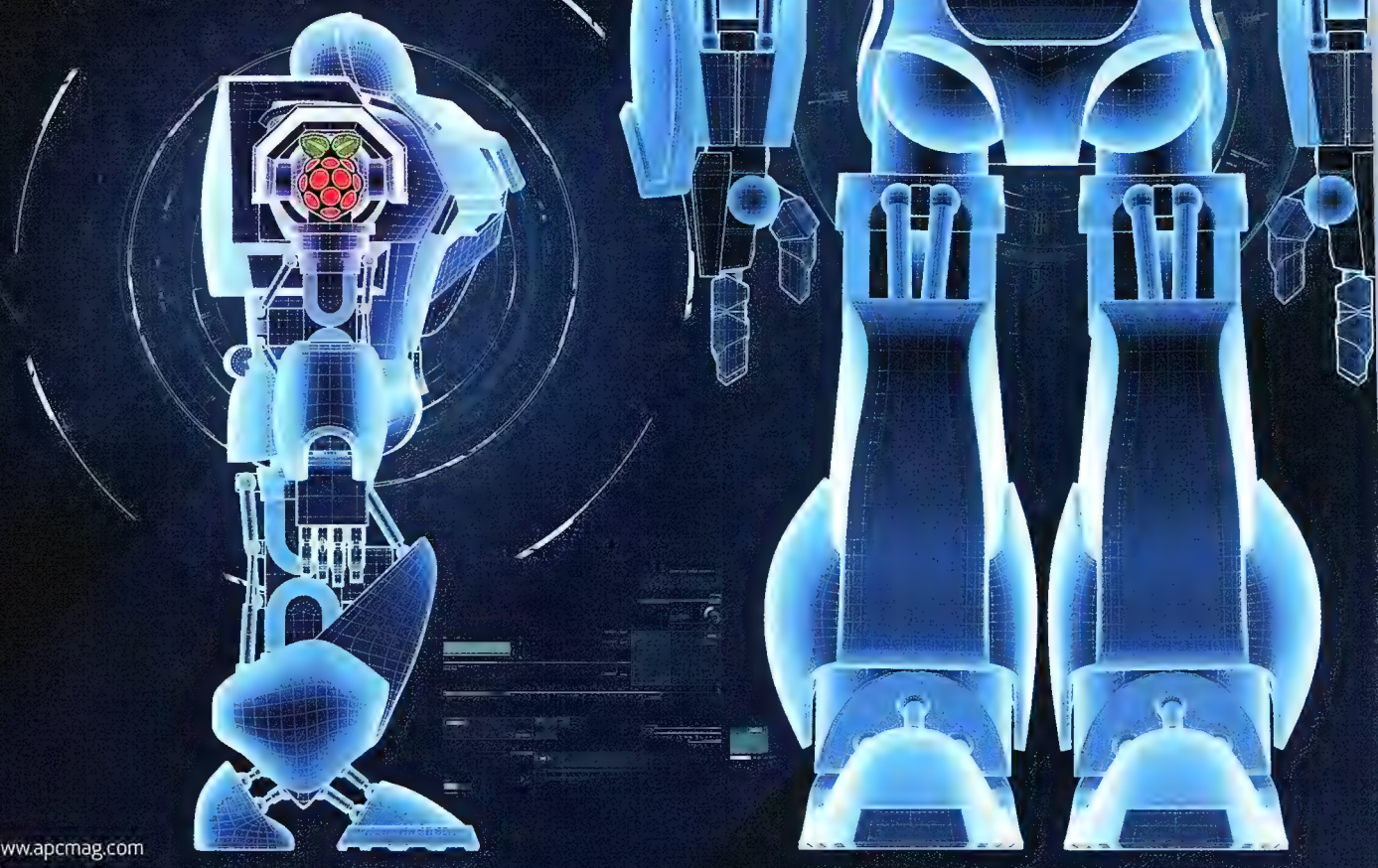
Supervillain Jonni Bidwell is constructing an army of Pi robots. Sneak into his lair and steal his techniques!

Robotics needn't be about building intimidating humanoid automatons. We can build machines that can perform all kinds of other useful, instructive or fun functions. Even better, you can power them with Linux.

You won't need costly electronics to build these devices – a Raspberry Pi will do just fine. It doesn't need to be any more advanced than constructing a LEGO set, either. There are plenty of off-the-shelf kits suitable for any budding electronics enthusiast.

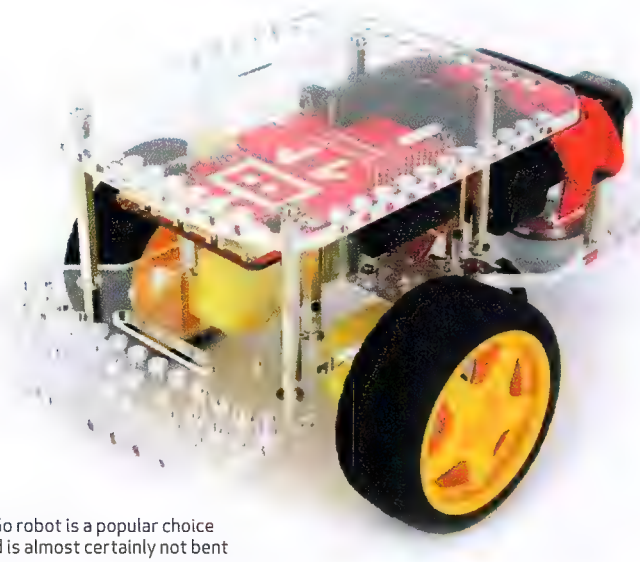
We'll reveal how to put together your own roving robot, and show you a couple of neat Python programs to get you started. And if you're feeling more adventurous, then why not build your own robotic helpers from scratch? All the components are easy to get hold of, thanks to the growing maker community.

If you want to take it to extremes, then 3D print your own custom parts and add some pseudo-sentience to your creation with some machine-learning voodoo. Or build your own robotic pet and have it follow you around like a puppy. The possibilities are endless. So power up that Pi, get yourself some components and let's start hacking some robots together.



A Pi bot's potential

We're not talking about engineering an Arnie-shaped T-101: Pi Edition, but don't let us stop you from doing so.



The Dexter GoPiGo robot is a popular choice for education, and is almost certainly not bent on world domination.

The Raspberry Pi was launched six years ago, and since then, it has grown into something amazing. We've seen four different major versions (Zero, 1, 2 and 3), and a couple of minor versions, most recently the powerful 3 B+ which launched in March.

Online Pi retailer **ModMyPi.com** was there at the beginning, and was good enough to lend us some treats for this feature. Founder Jacob Marsh offers his take on the Pi's remarkable success. "I didn't realise that the Raspberry Pi would grow to what it is now, I don't think even the Pi Foundation did. ModMyPi was conceived in a university bedroom. Now we have a global e-shop with more than 2,000 product lines, a $5.5 million turnover, seven full-time staff, and a 300 square metre warehouse that we're rapidly outgrowing. Long may it continue!"

What makes the Pi so special is the limitless scope for expansion. A tiny general-purpose computer that can be connected to sensors, motors or your central heating system, coupled with the collective imaginations of the open- source community, has led to all kinds of wonderful physical computing applications. And one of the most wonderful is robotics.

Nevermind our fanciful cover illustration. Any situation where a computer-controlled device performs a mechanical function is a 'robot' at heart. Robotic vehicles are particularly popular with Pi hobbyists just now. These might at first appear to be little more than the radio-controlled cars, but they can do much more than scoot around the kitchen table or living room.

Having a tiny Linux machine inside enables all kind of tinkering. With a few easy-to-connect components, some open-source libraries and just a little bit of Python programming to connect everything together, you're limited only by your imagination. Well, small caveat, you may have to solder a few wires. This is daunting at first, but there are plenty of guides on the internet. In particular, check out the Pi Foundation's director of education Carrie Anne Philbin giving an excellent demonstration at: **youtu.be/P5L4Gl6Q4Xo**

A Pi robot can run the same Raspbian Linux we all know and love. It can connect to wireless networks, so you can SSH in and perform diagnostics while it's on the move. You can even run `apt upgrade` while it's driving around.

A Pi-powered robot might also take pictures, zoom around your house quoting Shakespeare or even take to the skies to admire the city below. With the aid of the OpenCV library and a little bit of image processing, we can give our robot computer vision, so that it can target and follow objects, or even recognise objects or people.

So dig into our guide, and don't forget to check out **www.modmypi.com** for inspiration.

"A Pi-powered robot might take pictures, zoom around your house quoting Shakespeare or even take to the skies."

Robot Platforms

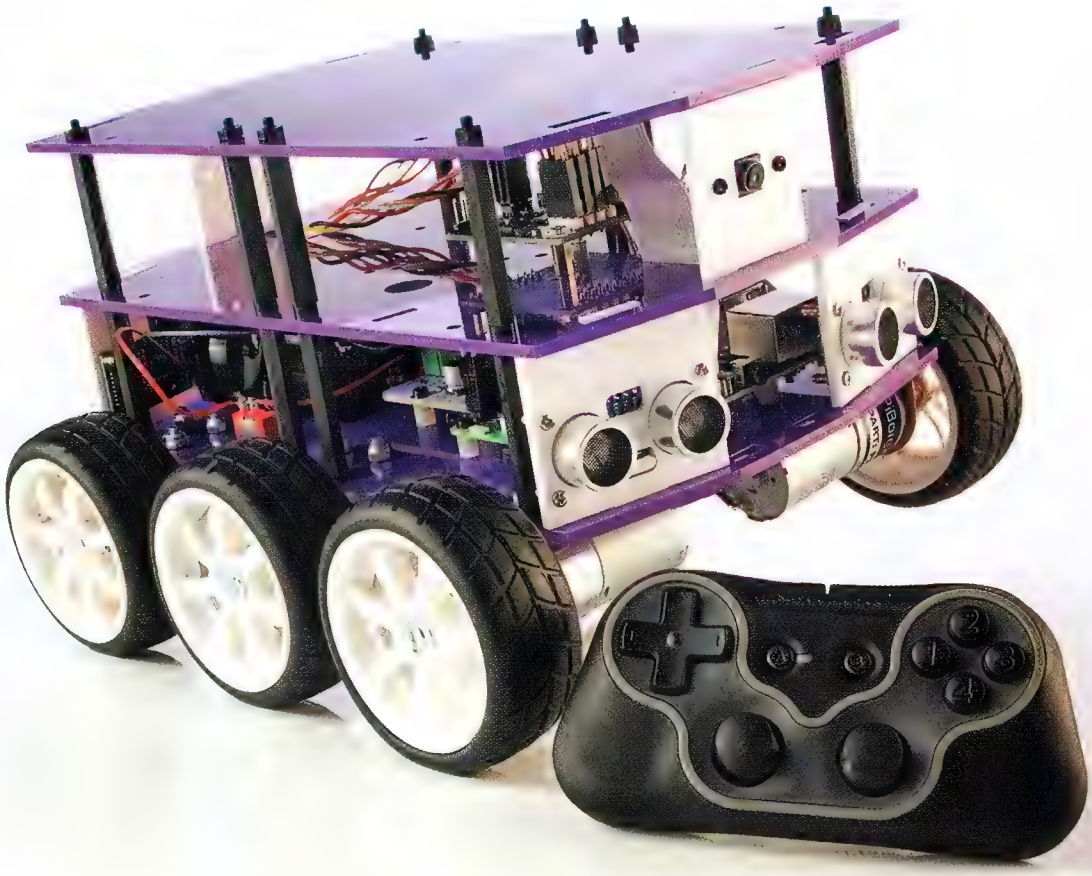
We'll concentrate on bread-and-butter software, namely Raspbian and Python, but there are a number of interesting platforms than can be run on top of, alongside or instead of these.

One such platform is Robot OS (ROS, see **www.ros.org**) which isn't really an operating system at all, but more of a middleware. ROS is a BSD-licensed project with thousands of contributors worldwide. It can be built from source for Raspbian, but since it provides packages for the Pi edition of Ubuntu MATE, that's the preferred base. ROS aims to be truly general-purpose robot software that works on many platforms and encourages collaboration.

We're also impressed with the work of Dexter Industries (**www.dexterindustries.com**), which makes the GoPiGo robot car. This is a kit designed for the classroom, and is programmed using Bloxter, a browser-based language similar to Scratch. Within the Blockly interface, it's possible for more advanced students to program in Python, too. Fans of Lego will enjoy Dexter's BrickPi, which connects the Raspberry Pi with the popular LEGO Mindstorms kit. If that weren't enough, it also makes the Grove Pi, a kit of 12 plug 'n' play sensors for exploring IoT programs.

Building the DiddyBorg

Robot construction is much more straightforward than you think. Let us show you how...



The good people at ModMyPi were kind enough to send us a DiddyBorg v2 to play with. We're super grateful for this and we thoroughly recommend you check out their store next time you need anything Pi-related.

The Borg series was designed by PiBorg, brainchild of Timothy Freeburn, who explains that "the DiddyBorg is a six-wheel drive robot and is a homage to the Sojourner Mars Rover". PiBorg teamed up with ModMyPi back in October 2017. Jacob explains this collaboration: "Tim and I were both around during the genesis of the original Raspberry Pi B. Where I was off making cases, Tim was designing motor-controllers and LED thingies (**www.piborg.org/ledborg**), so when ModMyPi developed into wider reselling, Tim's products were some of the first that we picked up.

"As the market has progressed over the years, we realised the need to bring in more in-house development, and Tim realised the value in utilising our distribution network for his products. He could devote time to making more cool stuff, and we could devote more time to selling and sending. We both work well at our respective goals and get along, so it was a no-brainer to team up!"

Our Diddyborg features six powerful 12V 100RPM motors and is powered by 10 AA batteries. We'll look at alternative power sources later. Power is distributed by the custom ThunderBorg board, which can handle 5A per motor, has a multicolour LED (useful for monitoring battery status) and we're sure you agree looks like the business. Rather than using some complicated servo arrangement for steering, the DiddyBorg rotates by turning its wheels at different speeds.

The borgs and many other robots are sold as build-it-yourself kits. Depending on the particular kit, this might be quite an involved process, involving small parts, soldering and possibly swearing. Building the Diddy takes a couple of hours from start to finish, and you can find instructions at **www.piborg.org/blog/build/diddyborg-v2-build/diddyborg-v2-build-instructions**. It would be silly to reproduce these in their entirety here, but do check out our general step-by-step robot building guide (right). We've based it on the DiddyBorg, because we have one, but construction of other robots will follow a similar prescription.

If you can, it's a good idea to set up the Pi as best you can before starting the build. Of course, it's possible to SSH to the robot once it's built to tweak things (so long as you've told it about your wireless network beforehand), but heavy wireless usage will sap battery power that could otherwise be used for careening around the office annoying the ads guys. If you have another Raspberry Pi and nimble fingers, then you can extract the SD card post-construction and perform any tweaks on the other device.

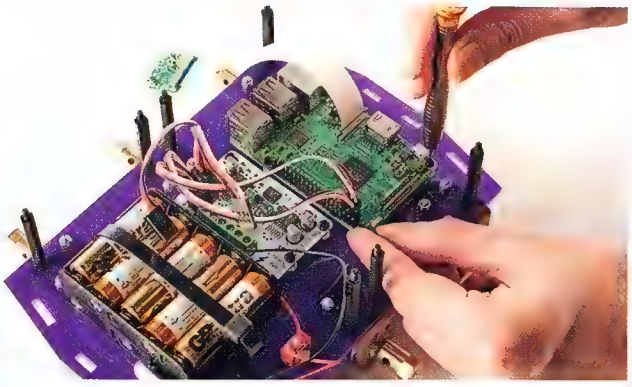
Building a Pi robot

1 ORGANISE YOUR WORKSPACE

We know how tempting it is to just dive right in and spill the contents of all the bags over your already messy desk. Don't do this. Instead, clear a nice workspace, read the instructions carefully and place all the tools you'll need to one side. If you have to solder anything, then make sure this happens in a well-ventilated area, and have some desoldering wick to hand.

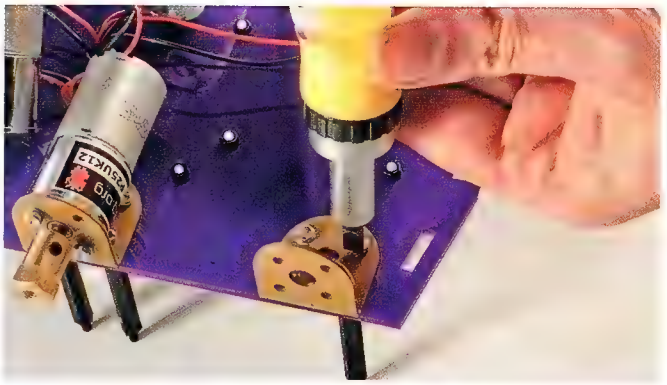
3 ATTACH MOTORS AND CONTROLLER

Fix the motors in place with the appropriate screws. The DiddyBorg uses spring-lock washers to ensure friction even if the holding screw is loosened. You really don't want your motors detaching while your robot is in motion. Now attach the motor controller to the chassis, or attach any required standoffs and then do so. Pay attention to the controller's orientation here.



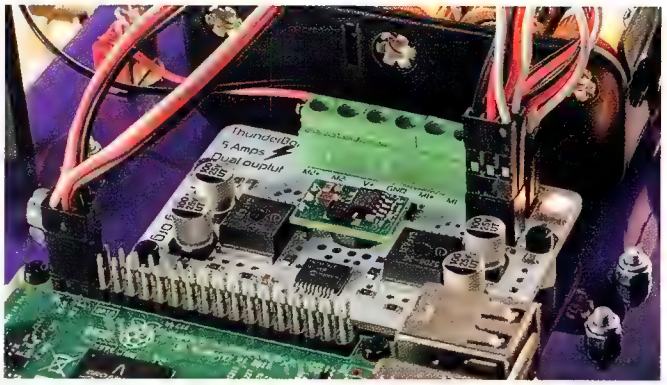
5 ATTACH YOUR PI AND BATTERIES

Affix the battery pack and switch to the chassis, and then connect them to the controller. For more powerful robots, this might involve heavy-duty wiring compared to the motors. Ensure that the SD card is in the Pi (and that Raspbian is set up to use your wireless network and Bluetooth controller) and attach the Pi to the chassis. Take care not to overtighten the screws.



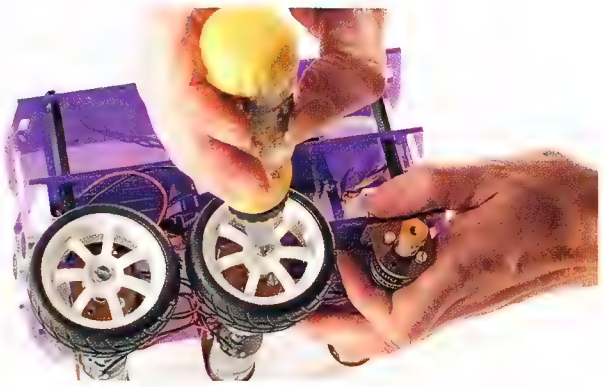
2 FIX THE MOUNTS

The motors will usually attach to the underside of the chassis by way of some angled brackets. Find the right holes and attach these brackets with the appropriate nuts and bolts. The DiddyBorg uses metal posts to secure the brackets. Don't forget to add washers if your chassis needs them. These help to distribute force and will protect against chassis fractures.



4 SOLDER AND ATTACH

Cut the required lengths of wire and strip the ends. We can't tell you how to solder from the confines of this small box, so be careful. Solder the red wires (if appropriate) to the positive sides of the motors, and the black ones to the negatives. Use a piece of tinfoil to catch any drips and protect the chassis. Connect the wires to the appropriate controller terminals.



6 FINISH THE JOB

Connect the controller to the correct GPIO pins on the Pi (ensure that the connectors are oriented correctly). Attach any other robot peripherals (such as sensors or cameras). Fix the wheel hubs to the motors securely with grub screws, and check that there's sufficient clearance for them to turn freely. Finally, put the wheels on the hubs and screw them firmly in place.

Keep your robot busy

What you do with your robot is limited only by your imagination and attention span. But for now, here are a few suggestions to inspire you.

Having constructed our Diddy, we wanted to know more about what it could do. Not content with making glorious hardware, PiBorg also provides some great code examples to get you started. These will need some tweaking to work on other hardware, but should give you some idea of how to talk to the hardware in Python.

Robot kits will provide scripts to deal with all the low-level communication. In our case this is all done through the ThunderBorg.py file (see **www.piborg.org/blog/build/thunderborg-build/thunderborg-examples**). This handles all the raw I2C coding, so you don't need to worry about that, and provides much more human-friendly functions such as `SetMotor1()`, which sets the speed of the left-hand wheels.

WEB CONTROL

Assuming your Pi is connected to a wireless network, then one slightly roundabout way to control it is to have it run a small webserver with an HTML form to control it. If your robot has a camera attached, then you can stream the video to this webpage, for a delightful first-person video driving experience.

Creating a streaming video processor in Python is less complicated than you'd think, but more complicated than we'd like to get into in this summary. So study the DiddyBorg web UI example at **www.piborg.org/blog/build/diddyborg-v2-build/diddyborg-v2-examples-web-ui** to see how the magic happens. If you're are lucky enough to own a DiddyBorg, then copy that script to it,

GAMEPAD CONTROL

Controlling your robot with a gamepad is a little easier to get along with. However, as we discovered, they might need a little persuasion to work when a GUI isn't running (such as when your Pi isn't connected to a monitor). In theory, you could set this up beforehand, or by removing the SD card from the robot and booting it in another Pi – the settings should be remembered. If not, we can set this up by SSHing into our robot.

There are two challenges to overcome: the actual Bluetooth pairing and the subsequent setting up of the device nodes. The latter is handled by the `joystick` package (or `evdev` which it depends on) and the former by the `bluetoothctl` command (this will be installed as standard). After installing the joystick packag, run `bluetoothctl`. This will start a console where we can scan, pair and connect our controller. First, put the device in pairing mode and then initiate a scan with `scan on`. You should see a list of all nearby Bluetooth devices and their MAC addresses. Hopefully your controller is in there, in which case copy the address. Deactivate the scan with `scan off`. Then pair with `pair <MAC address>`, connect with `connect <MAC address>` and take your leave with `exit`.

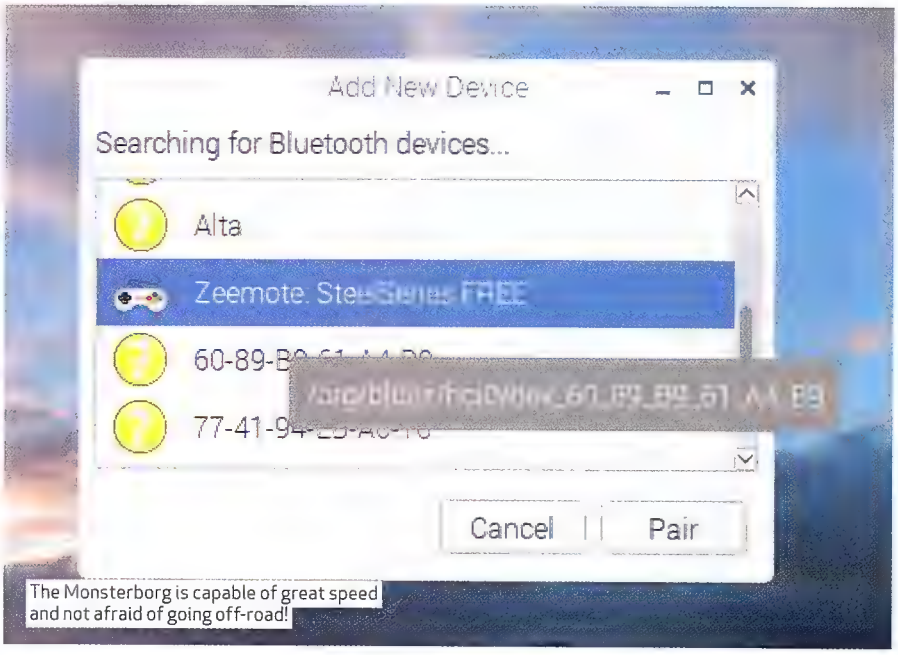
Now run `evtest`, which will greet you with a list of detected input devices. Select your desired controller and mash the buttons. You should see a different cryptic response for each button. The DiddyBorg includes an example script for joypad control, which uses the PyGame libraries to listen for the relevant button events.

IMAGE RECOGNITION

Tensorflow is all thanks to the work of Sam Abrahams, who's provided precompiled wheel files for Python 2.7 and 3.4. This is good news if you're running the second-to-last (Jessie) version of Raspbian, since that includes Python 3.4. If you're running the latest version (Stretch, which uses Python 3.5), however, then you'll need to use the Python 2.7.

Having two different major versions of Python like this is fine (Raspbian ships them both as standard), but one cannot have 3.4 and 3.6 installed concurrently, and the 3.4 wheel won't work with Python 3.6. Before we begin, be advised that Tensorflow models' repository is large, and more than once, we ran out of space using an 8GB SD card. This can be worked around, by removing larger packages such as LibreOffice and Wolfram Alpha, but using a 16GB card

> "If your robot has a camera attached, then you can stream the video for a delightful first-person video driving experience."



The Monsterborg is capable of great speed and not afraid of going off-road!

is recommended. The following will set up everything you need:

```
$ wget https://github.com/samjabrahams/tensorflow-on-raspberry-pi/releases/download/v1.1.0/tensorflow-1.1.0-cp27-none-linux_armv7l.whl
$ sudo apt install python-pip python-dev python-pil python-matplotlib python-lxml
$ sudo pip install tensorflow-1.1.0-cp27-none-linux_armv7l.whl
$ git clone https://github.com/tensorflow/models.git
```

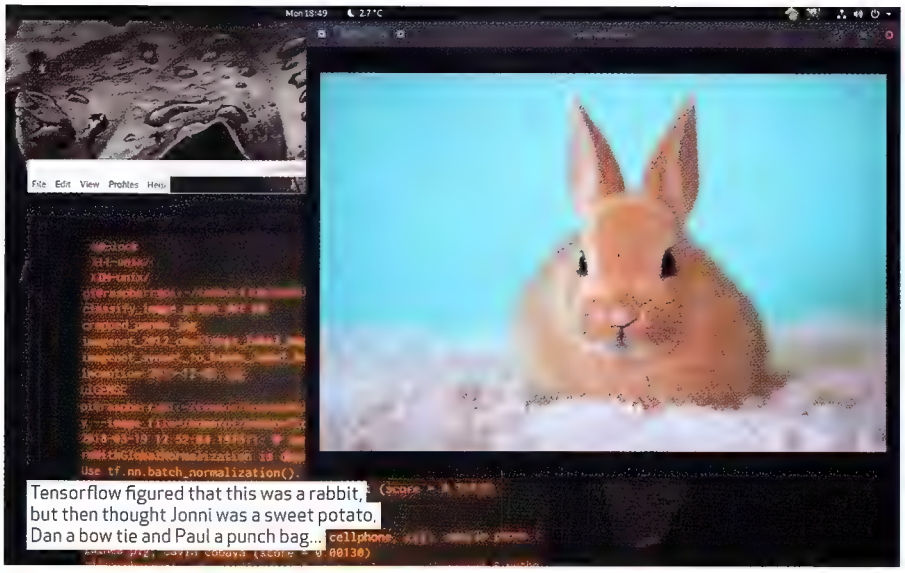
This last stage will start a roughly 1GB download, so beware. If you run out of space, the process can be resumed, once you've cleared some clutter, by running `git checkout -f HEAD` from the models/ directory. Once it completes successfully, test it:

```
$ cd models/tutorials/image/imagenet
$ python2 classify_image.py
```

This should identify the bundled panda image (which was extracted to /tmp/imagenet/cropped_panda.jpg). The script can also take an `--image-file` parameter to identify user-supplied images. So we could adapt things to take a photo and then attempt to identify it. Since the whole process takes about 10 seconds on a Pi 3 (although this could be sped up by keeping the program running in a loop, using C++ or with a more slimline Tensorflow model), we don't really have any hope of classifying things in real time. Furthermore, it's likely that a photo taken at ground level with the Pi Cam will be tricky for the script to identify. But that's OK, it just adds to the fun. All we need to do is tweak classify_image.py a little. Copy this file to classify_photo.py, then edit the new file. You'll need to import the picamera module early on, then in the main(_) function, replace the line that begins with "image =" with something like:

```
cam = picamera.PiCamera()
cam.capture('/tmp/picam.jpg')
```

And finally, change the `run_inference_on_image()` call to run on our freshly captured picam.jpg. If you're feeling adventurous, why not bind the new script to some button press event? The controller script for the DiddyBorg could easily be adapted to do this.



Tensorflow figured that this was a rabbit, but then thought Jonni was a sweet potato, Dan a bow tie and Paul a punch bag...

The Borg series

Resistance is futile. PiBorg's Borg series consists of three robots: the DiddyBorg (£210, or about $380), the MonsterBorg (£210) and the YetiBorg (£160, about $290). The DiddyBorg's distinctive flat top makes it possible for all kinds of things to be mounted atop it. A terrifying robot claw, for example. It can be reconfigured with the Multifunction Top to fit an additional Pi, or with the Touch Top to fit the official Raspberry Pi touchscreen. It can also be kitted out with front and rear Pi Cameras, as well as ultrasonic sensors for obstacle avoidance.

Then there's the MonsterBorg, a machine not to be trifled with. Its chunky four-inch wheels enable it to chew up off-road terrain. As you may have read in the News section, PiBorg organises the Formula Pi racing event, and racing is what the MonsterBorg does best. Its 3mm -thick aluminium chassis ensures that it can survive all but the messiest of crashes.

Finally, there's the nimble YetiBorg. Powered by a Pi Zero (included) and a single 9V battery, the YetiBorg uses the custom ZeroBorg motor controller. This enables independent control of its four motors. It can be assembled in two different configurations: low-profile and off-road. In low-profile mode, should it accidentally flip over, then it's perfectly capable of continuing upside down. If a little more clearance is required, then the off-road mode will keep the chassis clear of bumps and the electronics shielded from puddles.

[redacted]

OpenCV is a powerful computer vision framework that includes Python bindings. It's actually used to draw the image in the earlier Web UI example, but we can use it for more advanced purposes. It's capable of detecting objects within an image, which means we can make our robot drive towards them. If those objects move, then it will follow them. For this to work, said objects need to be fairly distinct, such as a brightly coloured ball. You'll find just such an example at **www.piborg.org/blog/diddyborg-v2-examples-ball-following**.

We need to convert the image to HSV so that OpenCV can better detect any red ball-like objects to follow.

Kit out your robot

There's a whole world of weird and wonderful widgetry that can be fitted to your robot to add functionality and bring the fun!

A simple Pi robot needs little more than a chassis, power source and wheels. But things are more fun when you kit the base construction out with some additional peripherals. We can use well-known Pi peripherals, such as the camera and the touchscreen, in new and innovative ways, or we can use other items – sensors, speakers, servos and more – to really ramp up the excitement levels.

GRAB YOURSELF A CONTROLLER

Controlling a robot via a web interface is all well and good, but even on a fast network, you'll experience some degree of latency, which will make driving a little haphazard. A wired controller will work reliably, but obviously, this won't be much use if you can't keep up with your robot. With a Bluetooth controller, you can enjoy much more precise control of your robot friend. PlayStation 3 joypads are very popular when coupled with the sixpair utility. See **www.piborg.org/blog/rpi-ps3-help** for details. There are a number of other options, though, and many of them will work out of the box with Raspbian. Class 1 Bluetooth devices in theory have a range of up to 100m, but these are subject to interference and dropouts.

Also, if you don't have a Pi 3 or a Bluetooth adaptor, then this isn't an option anyway, so it may be worth considering using an alternative means of transmission and reception. The go-to option here is to use radio frequency (RF) in the 2.4GHz band. This requires a more powerful transmitter, such as what's used in drones and other radio-controlled aircraft.

GET A PI CAMERA

Whatever you want your robot to do, you can't go too far wrong by giving it the gift of sight. This can easily be done with the Pi Camera board, available from all good maker shops. Launched in 2013, the Pi Camera Module was one of the first official add-ons for the Pi and has found its way into all kinds of amazing projects. A new 8MP edition came out in 2016, and a mini-edition for the Pi Zero followed suit.

These cameras connect via a ribbon cable to the bespoke CSI interface, leaving the GPIO pins free for other gubbins. A mount is available so that the camera can be easily and securely attached to wherever it needs to go, and if flexibility is required then a variety of pan-tilt kits are available for pitching, rolling and yawing to the ideal angle. There are also telephoto, fish-eye and wide-angle lens kits available. We saw on the previous pages how libraries such as OpenCV can be used to detect objects using camera input. If you want to incorporate the Pi Camera into your camera projects, then this one-liner will help you:

```
$ sudo apt install python-picamera
```

ADD MOTION USING SERVOS

Servos are motors (*Actually actuators – Ed*) that often have a limited movement range, for example, to move the rudder of a radio-controlled boat, but some can, or can be adapted to, do continuous rotation.

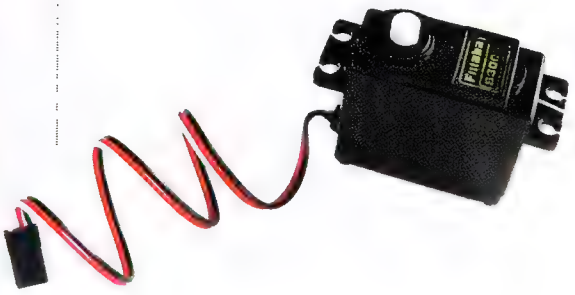
Servos are controlled by pulse-width modulation (PWM). These pulses need to be pretty accurate, otherwise the servos will get confused. For example, a servo may have three different positions: left, up and right, say. The position is determined by the length of each pulse, a 1ms long pulse may indicate the left position, a 1.5ms pulse may stand for up, and a 2ms pulse may move it to the right. So there's not much room for error.

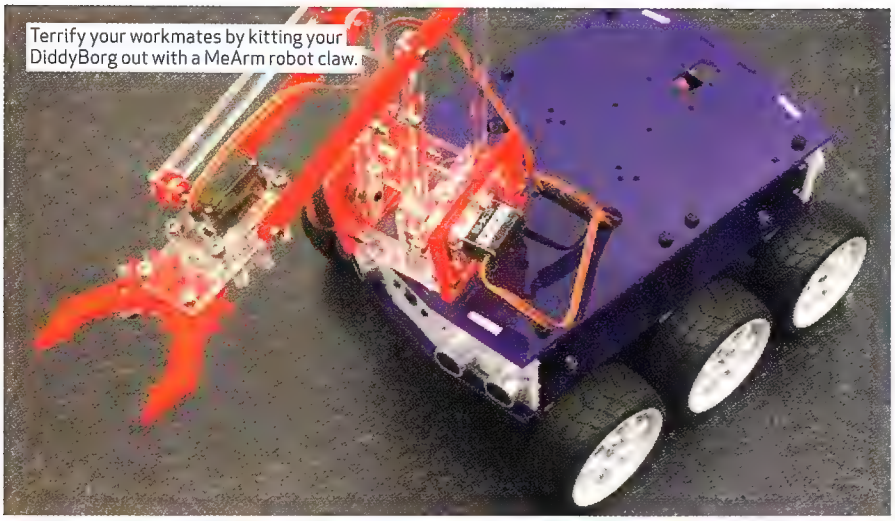
One of the Pi's GPIO pins is connected to a hardware pulse generator, so that these pulses can be generated without being interrupted, or elongated by a busy OS. However, sometimes one pulse generator isn't enough and it's common to add a HAT or other expansion board (possibly even a whole new microcontroller such as an Arduino) to handle multiple PWM devices. See how the UltraBorg can achieve this over a web interface at: **www.piborg.org/blog/build/ultraborg-build/ultraborg-examples-web-ui**

IMPROVED BATTERY POWER

The Pi itself can distribute power to small devices through its GPIO pins. But these are limited to 3.3V and can carry very little current. So powering high-torque motors, lights or weapons (*Say what now? – Ed*) through these, with the Pi connected to a standard USB power bank, isn't an option. We've seen that the DiddyBorg gets its juice from 10 AA batteries But the current portable power trend is definitely lithium ion polymer (LiPo) batteries. They provide longer life and higher

We found this handy little Bluetooth gamepad discarded in a dusty corner at APC Towers. It came in surprisingly handy for this feature.



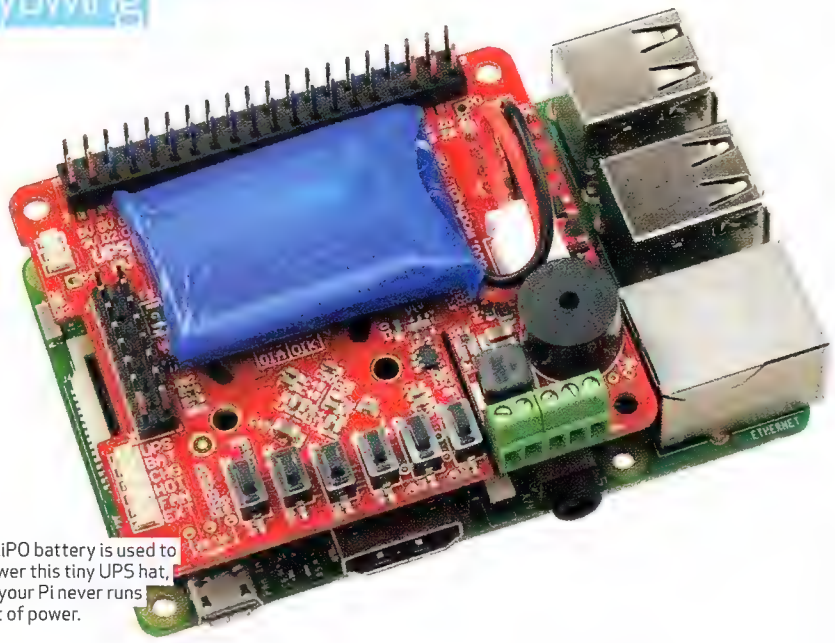


Terrify your workmates by kitting your DiddyBorg out with a MeArm robot claw.

"If camera flexibility is required, then a variety of pan-tilt kits are available for pitching, rolling and yawing to the ideal angle."

power than their nickel metal hydride (NiMH) brethren, and also hold a charge for longer.

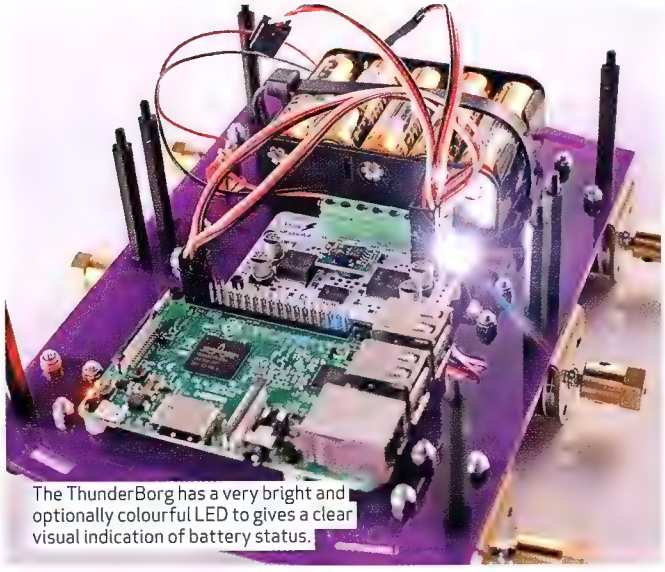
Batteries will suffer voltage drops as they approach the end of their lives, and some components (not least of which is the Pi itself) are pretty sensitive to these. So one of the important tasks that the ThunderBorg, which connects the DiddyBorg's battery pack to the Pi, performs is regulating the power supply. If too low a voltage is detected when the board is powered, then it will duly switch itself off. Tim Freeburn told us a bit more about this stylish creation: "We're very proud of ThunderBorg. The wide voltage range was a key part of the design from early on. ThunderBorg has a wide range of protection mechanisms such as undervoltage lockout, short circuit protection, thermal protection and overcurrent protection. Thanks to this, it's pretty hard to destroy one, as long as you make sure you connect the power supply the right way around!"



A LiPO battery is used to power this tiny UPS hat, so your Pi never runs out of power.

[illegible]

Besides using a camera to assess its environment, our robot can also be like a bat and use ultrasonic chirps to map things out. An ultrasonic sensor, such as the HC-SR04 emits periodic, high-pitched pulses that can detect as they bounce off nearby objects. By measuring the time between emitting the pulse and detecting its reflection, and knowing that the speed of sound is about 340 metres per second, the sensors can judge distance reasonably well. Our DiddyBorg came with a kit for mounting these sensors at each corner. You could use such a sensor array to automate parallel parking.



The ThunderBorg has a very bright and optionally colourful LED to gives a clear visual indication of battery status.

The DiddyBorg can be kitted out with four Ultrasonic sensors to let it know if obstacles are approaching.

Watch the skies

Pssst, wanna get high with the Pi (in complete compliance with local aviation laws of course)?

Aerial flora photography

The Pi NoIR camera has no infrared filter, which enables it to 'see' in the dark, making it useful for CCTV applications. The retail package also includes a slightly quizzical blue gel square. When that blue square (Roscolux #2007 Storaro Blue to give it its full designation) is placed in front of the lens, red and green light are filtered out, and the sensor shifts infrared light to the red spectrum, enabling hyperspectral images of plants to be captured.

The actual photo taken is an NGB (Near infrared Green Blue) image, which doesn't reveal very much. But with a bit of post-processing magic, a composite NDVI (near difference vegetative index) image can be generated, which shows how well the plant is photosynthesising, or more crudely, how healthy it is. This technique used to require specialist equipment, mounted on aircraft and satellites. For serious applications it still does, but have a look at the infragram projects at **publiclab.org/wiki/raspberry-pi-infragram**, and in particular Matthew Lippincott's Flickr page at **bit.ly/raspberry-pi-infragram**, to learn more about what can be achieved with the humble Raspberry Pi.

So far, we've managed to keep our feet/wheels/caterpillar tracks on the ground, but we think we should finish our robotic journey with a brief foray into the world of drones.

Keeping a drone in the air is a complicated business. Each motor has to be able to respond as close to instantly to changes in orientation. These are detected by a three-axis accelerometer. Other instrumentation is required, too: gyroscopes, servos and, of course, motors to keep the propellers turning and generate lift. A vanilla Linux Kernel isn't built to respond within such operational deadlines as this, so it's common for drones to run a real-time OS (RTOS) such as NuttX, or indeed a proprietary OS. The Linux kernel can be tweaked to get closer to such response times though. The PREEMPT_RT patchset is probably the most popular way to achieve this. This patchset, having gone for a long time without funding, is now part of the RTL Collaborative Project, an industry-sponsored initiative under the Linux Foundation. See **wiki.linuxfoundation.org/realtime/rtl/start** for more information.

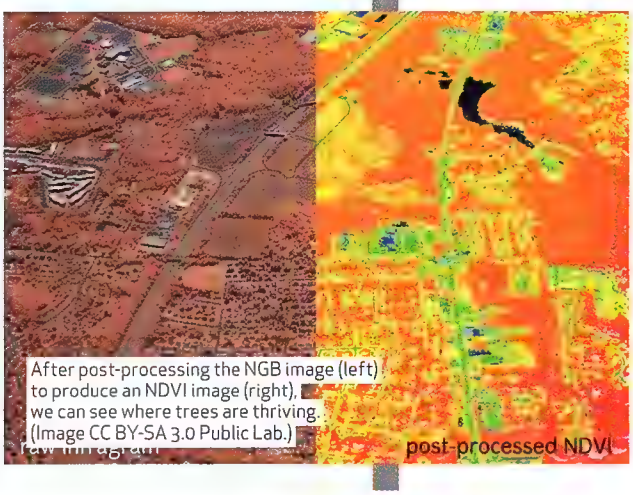
Erle Robotics (**erlerobotics.com**) makes the Erle Brain: small Linux computers capable of fulfilling all the functions required to keep a drone in the air. They include all the sensors and expansion ports you could imagine. Erle also makes the PXFMini, a hat for the Raspberry Pi that uses Dronecode's APM Flight stack. Dronecode is an open source platform that's fast becoming an industry standard. The stack consists of the PX4 autopilot, the Mavlink communication protocol, QgroundControl software and runs on a huge variety of hardware. Read more at: **www.dronecode.org**

Even if drone makers often would rather have some other OS flying their aircraft, it doesn't preclude having a separate Linux machine on board. This may even be advantageous, since it enables all of that machine's resources to be devoted entirely to fun tasks, perhaps 360° photography via a gimbal-mounted camera.

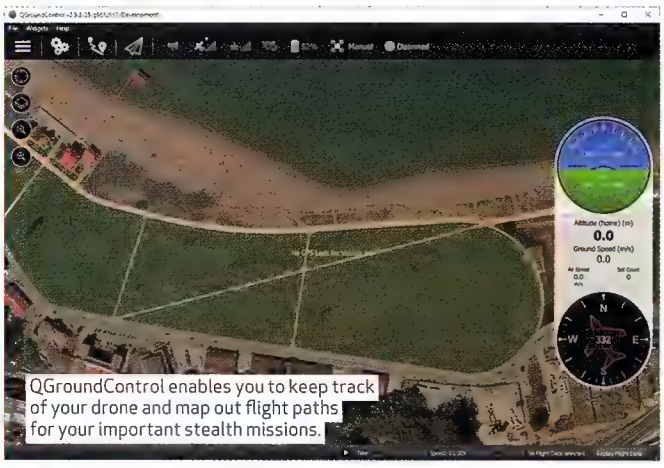
It feels like we've barely scratched the surface of Pi robotics. PiBorg founder Timothy Freeburn tells us he's "working on Pi-based robots for mining simulations with a big Australian mining company, robots for aircraft intake and exhaust duct inspection, and robots for pipeline inspection. The list is growing rapidly!"

He also points us in the direction of some of his favourite community projects: Pi In The Sky, The Big Hack, and Liam Kennedy's ISS-Above (see **issabove.com/iss-above-and-the-raspberry-pi**). Thanks, Tim.

Now, dear reader, off you pop and build something amazing!



After post-processing the NGB image (left) to produce an NDVI image (right), we can see where trees are thriving. (Image CC BY-SA 3.0 Public Lab.)



QGroundControl enables you to keep track of your drone and map out flight paths for your important stealth missions.

A DEEP DIVE INTO Google

We take a deeper look at the tech company behind many of the products we use every day.

When you think of Google, search engines and emails may come to mind, but there is a lot more to the company than just these runaway successes. It is true that Google dominates search and email, but did you know that YouTube is owned and powered by Google? In fact, so are many other online services that you may already be aware of. Over time, Google has grown from a company that provides the best search engine on the internet to one that can power almost every aspect of our computing lives. Google now provides the most popular email service in the world and enables people to store billions of documents online. It provides ultra-fast broadband and the operating system for the most popular smartphones – it sometimes feels that everything it launches becomes a global success. Google is with us all of the time, in the background and at the forefront of our productivity, leisure and travelling. The network of apps and services come together to create an ecosystem that has naturally grown and feeds off each part. Google is undeniably an unconventional company and, in many cases, its products have grown beyond being mere tools.

GOOGLE'S REACH

There are three tech companies in the world that most of us will have heard of: Microsoft, Apple and Google. However, only Google has managed to infiltrate our lives in such a complete way in a relatively short period and the reach is growing all the time. Millions of us use Google services for email and even more utilise the company for web searches on desktop computers, laptops, phones and tablets.

It doesn't stop there, though, because the reliable calendar software organises individuals and companies alike, and even online video is dominated by Google thanks to YouTube. All of this has a big impact on the tech landscape as a whole, but it's just the tip of an ever-growing iceberg, with Google and its parent company, Alphabet, always seeking new areas and opportunities to extend its reach. We can navigate for free anywhere in the world and view 3D recreations of famous places using Google Maps. We can store and share our photos online whenever the mood strikes us and Google Now is there to automatically prompt us when an event is happening, or to offer information that is pertinent to what we are doing next.

Remarkably, the services that we have mentioned so far, which have a huge impact on our lives, are not even close to covering all of what Google offers – the list is never ending to the point that, for many, it's hard to think of Google as just a company. We say to 'Google it' when undertaking a web search. People describe their phone as their 'Android' and, for some people, 'Gmail' is the only word they use to describe email.

Google services are embedded in our subconscious to the point that we no longer even think about them as single entities.

"Google services are embedded in our subconscious to the point that we no longer even think about them as single entities."

GOOGLE CULTURE

There's no doubt that Google has become respected or even 'cool' in a way that few organisations have managed... something that's even been highlighted by the release of Google-focused flick *The Internship*, a comedy that concentrates on the kind of wacky thinking that achieves greatness. It also highlights the working environment, which looks like a dream workplace in comparison to the uninspiring environments most of us inhabit on a daily basis, as well as demonstrating the ambitious thinking the company employs. An organisation that has a company dinosaur on campus called Stan and which lets employees take their dogs to work is obviously thinking outside the box, but the company also keeps a

History of Google

19 years of greatness

1998
It's born
Larry Page and Sergey Brin founded Google on 4th September 1998.

1999
Google get their first office dog, Yoshka.

2003
Google AdSense announced.

2004
Time to go public
The company grew and became public in August 2004.

2004
Gmail is born
Gmail was launched on 1st April 2004 and now has 900 million users.

2006
YouTube acquired
Google bought YouTube for $1.65 billion in October 2006.

The Googleplex is a uniquely fun and productive environment for Google employees.

herd of 200 goats alongside a herder and his dog just to keep the weeds at a manageable level on the main Google campus. Google has become a source of fascination because it is with us all of the time and impacts our lives in so many diverse ways.

AND THERE'S MUCH MORE...

So you now have an idea of how inventive Google is and the main services you can use, but there is so much more. If you want to create a presentation, word document or spreadsheet, you can do so within an online service called Drive. All of your documents are saved in real-time as you create them and they sit in harmony next to your contacts, emails, photos, calendar events, notes and reminders so that they can all work together to help you succeed. You can socialise through Google+, spend hours watching videos on YouTube and share your thoughts by creating a free blog using Blogger. Millions of Android apps will keep your phone or tablet humming and a simple translation from and to every major language in the world is just a couple of clicks away. Video calling, panoramic photos, books, music, image editing, finance, trends, education and... well, the list could go on for a very long time indeed. All of these services are tightly integrated with each other and, for consumers, are free to use – an integral part of the strategy that's helped Google become the giant it is today.

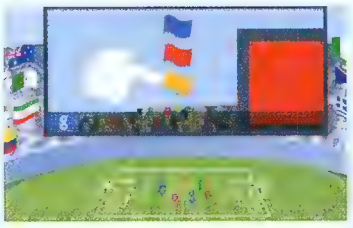
Google Doodles

Temporary alterations to the logo creates a sense of fun.

A simple celebration of the 175th anniversary of the Penny Black stamp.

Many local holidays such as St Andrew's Day 2014 have been celebrated.

Even total eclipses are covered with superb customisable live animation.

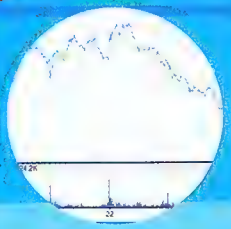


The majesty of the football World Cup final in 2014 received due attention.

Amelia Earhart's 115th birthday was celebrated in truly artistic fashion.

2009
Chrome announced.

2012
Google Fibre was launched in 2012 to provide ultra-high-speed broadband.



2015
Google announced revenues of $17.7 billion in the second quarter of 2015.

2016
Google launch their first self-made phone, the Google Pixel.

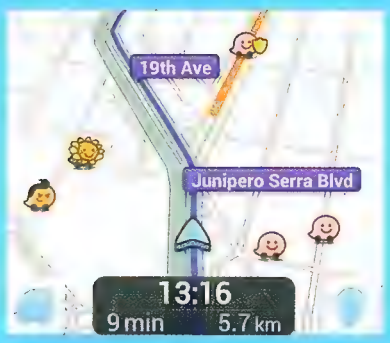
2017
Google's new voice-controlled device is launched.

The best of Google's hidden apps

A collection of lesser-known, but highly capable and useful Google apps and services.

You will likely know the most popular apps and services that Google runs, but there are other apps that the company has either acquired or developed over time that may surprise you. Some of these apps offer no obvious indication at all that Google is involved, but that they undoubtedly bear all of the hallmarks of the Google system behind the scenes.

From community-based navigation to image editing, Google's reach extends way beyond the obvious and into a variety of areas — many of which we've covered in our Android apps section (see page 45). The company is now even delving in to the world of home automation, too. There's almost no area in the tech world that Google hasn't attempted to touch. While some apps have been much more successful than others, here are five useful and interesting ones that are well worth a look.

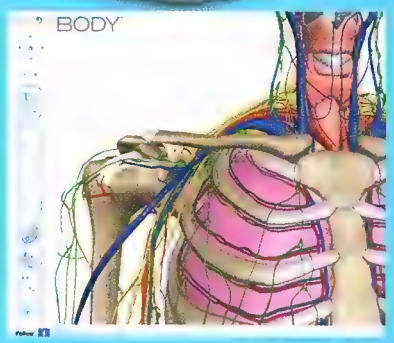


Waze

Waze is not like many other navigation apps, as it relies on the input of its users to guide people from A to B. Thankfully, it's proved to be exceptionally popular and so you can rely on a huge community, which is arguably more reliable than using satellites — the method most navigation apps have to use.

You will be offered the best routes and will be continually updated with the current traffic conditions, and the social aspect of the service feels pretty unique. The more you put in to the service, the more you'll get out, and you are rewarded for making an effort. This is why the service works so effectively and why Google felt the need to get involved in the project. It works best with friends because you can see where they are and vice versa, and even the maps are continually updated by an army of people who are looking for changes in roads and events all of the time.

Waze may feel too friendly to be taken seriously at first glance, with all the smiley-face cars, but the service works well. Definitely worth a try.

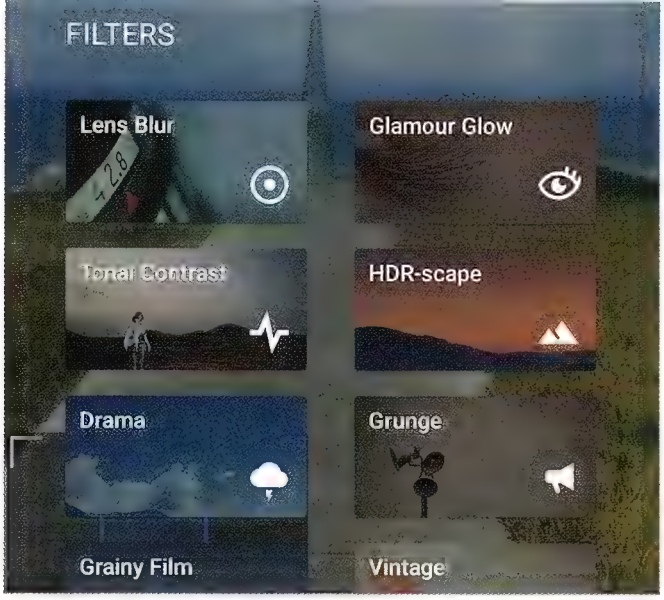


ZygoteBody

ZygoteBody was previously known as Google Body and is powered by the architecture that Google built. Even though it's not technically an app, it can be run on tablets and laptops with ease and is capable of educating and entertaining you both at the same time.

It displays 3D anatomical models of the human body, which can be used for medical training at a high level. You can view the muscle system, organs and almost everything else in a great amount of detail with just a tap or the click of a mouse. Focus has been given to the data that's on offer and it remains one of the most impressive and useful Google creations to date. Take a moment to look at the service and you'll be impressed by the sheer amount of accurate and interesting data on offer.

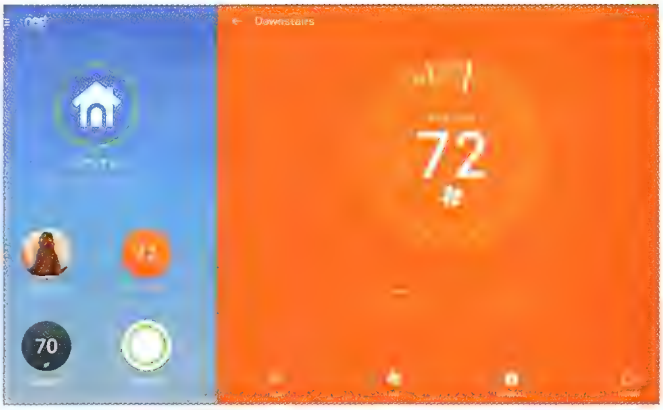
"It can be run on tablets and laptops with ease."



Snapseed

Edit images in seconds.

Originally developed for iPad, Snapseed was bought by Google back in 2012. It is now available as an app to install on both phones and tablets. A photo editor is not particularly original or unusual, but when you use Snapseed, it soon becomes clear that it is a simple-to-use, consumer-friendly solution that is capable of transforming an average photo into a work of art. The filters are diverse and easy to adjust, as is the large range of editing tools. The quality of the tools rival some of the more expensive desktop apps, and if you gel with the interface and options, you could soon make it your go-to touch-up app. There are, of course, more complex options out there, especially for more serious on-the-go image editors, but for the asking price of a whole zero dollarydoos, it's quite tempting.



Nest

Google software meets impressive hardware.

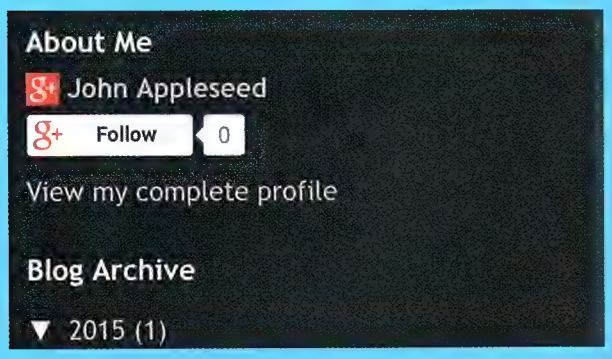
The Nest thermostat changed the way many people view static household objects thanks to its minimalistic design and connected ease of use. Google spent $3.2 billion to purchase the company and it still works as it always did. Grab the app to quickly change the indoor temperature when away from home and also manage many other aspects automatically. With the right accessories, it can detect smoke and carbon monoxide, and it can also be used as a viewer to see what's happening in your home through a Nest Cam. Google has kept the hardware at the same high level it was at, thankfully, and is working towards making sure that all Nest products are more connected and intuitive than ever before.

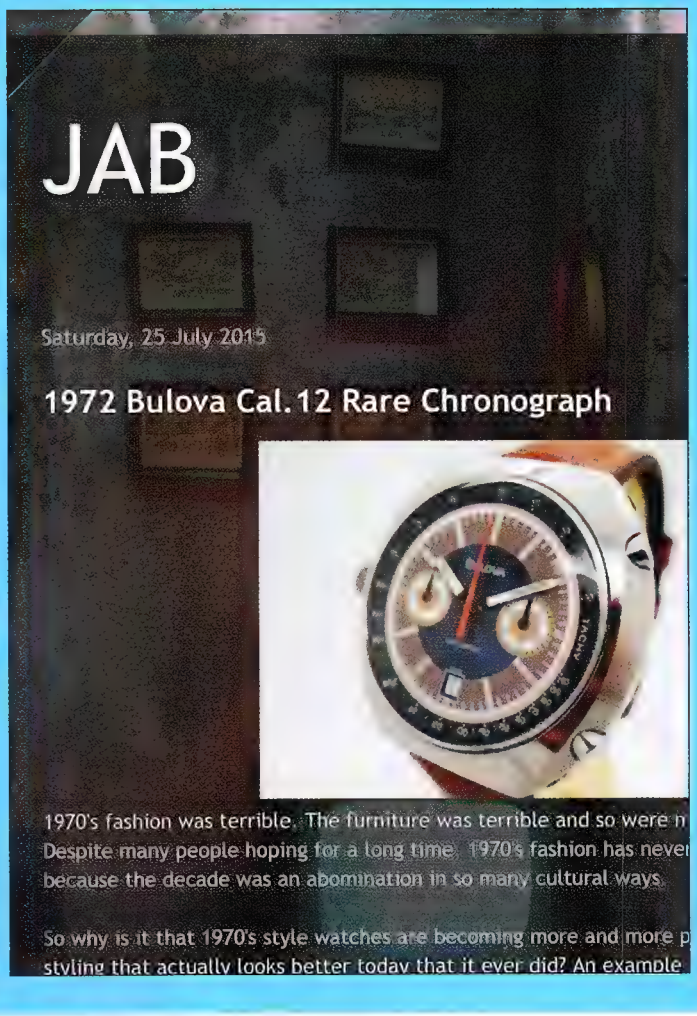
Blogger

Blogger is one of Google's longest-running services, and is still seen by many as just another blogging service, but it does offer advantages over some of the competition. For a start, it is free and you can redirect a custom domain to your blog for free, which most providers don't offer. Also, being a Google product, it has the ability to help you build a large readership more than any other company.

The Blogger platform is not the most sophisticated and the number of templates available could be bigger, but everything you need to get started is included. It caters for new bloggers and experienced writers alike, but once complete, the blogs must be held online on Google's servers. While not ideal for all, there is full support for all the popular web browsers, so you can be assured of a reliable and efficient experience no matter how large your blog gets or how often you update it. You can use Google's AdSense to generate income from your blog and also integrate it with Google+ for greater reach.

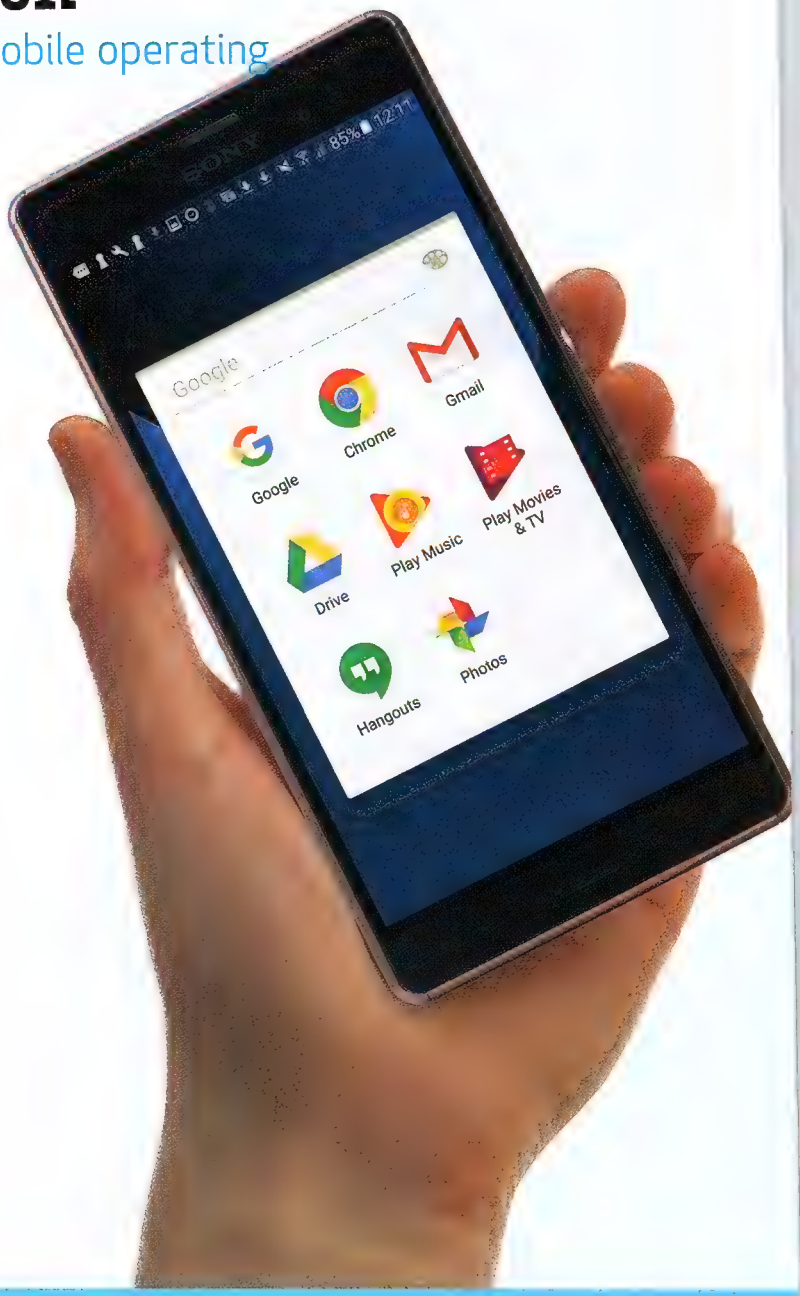
The fact that mobile apps are available for the service too means you can post when travelling.




JAB
Saturday, 25 July 2015
1972 Bulova Cal. 12 Rare Chronograph
1970's fashion was terrible. The furniture was terrible and so were n
Despite many people hoping for a long time, 1970's fashion has never
because the decade was an abomination in so many cultural ways.
So why is it that 1970's style watches are becoming more and more p
styling that actually looks better today that it ever did? An example

The mobile revolution

Google powers the most popular mobile operating system in the world.



Android as we know it today has become the dominant mobile operating system in a market that has been greatly expanded over the past decade. Smartphones and tablets are ubiquitous around the world and Android is well placed to cater for more people than any other platform out there. Google offers Android to any hardware developer that would like to build devices running it, and because of this, we have a plethora of phones and tablets at all price ranges that offer a similar experience. In many ways, it doesn't matter if Android is running on a budget device or a premium, because the core of the experience will remain the same. Millions of apps are available via Google Play and a range of Google services are designed to work just as well on Android devices as they do on desktops.

Google Music works especially well on an Android device and so does the official Photos service, and all of the other Google services have complementary apps that can offer all of the features of their desktop counterparts. Gmail, Chrome, Books, Movies & TV, YouTube, Hangouts, Newsstand and so many other services have been tailored for mobile with apps released by Google and each will share user data seamlessly with the main Google web services. Google Now is a very good example of a service which performs best when mobile because it is able to alert you to events and offer timely information when you need it. The Maps app is another example.

In a world where mobile is becoming so important that it could eventually outpace the desktop market and even the web itself, Android is well placed to cling to its current number-one spot for some time to come. Some of its devices are extremely affordable, so if you're already using many Google services and would like to experience them when travelling, it's super easy to jump on board the Android train.

The history of Android

The story of the most-used mobile OS.

Whether you were aware of Google's global prowess or not, one thing is abundantly clear, its mobile operating system — Android — is currently the most used across the globe. Here's a brief history of the story so far...

2003
Android Inc
In 2003, Android Inc was created by Andy Rubin.

2005
Google buys Android
Google bought Android Inc and its key staff in July 2005.

2006
LG Prada announced.

2007
The Open Handset Alliance
The Open Handset Alliance, which included Google, announced itself in 2007.

2008
Revealed to operate on Linux.

2008
The first Android phone
The HTC Dream, powered by Android, was launched in 2008.

The early days

Android had to battle against early smartphones and the threat of the iPhone from day one.

In the very early days of Android, the iPhone was receiving all of the headlines and was trying to drag early adopters away from traditional phones such as the Treo 650 and other smart niche devices. It was clear, however, that a new approach was needed for smartphones to gain mass market appeal and so Android was quickly developed to offer as complete a system as was possible at the time.

Phones dominated by screens were created alongside more traditional units with hardware keyboards, but it would be fair to say that the early versions were somewhat experimental. Just like the iPhone, the features were limited not just by the ability to create powerful software, but also by the slow mobile networks available at the time. Google invested heavily, both financially and with resources, and in a very short space of time, the initial versions of Android improved dramatically.

This approach captured the interest of smartphone manufacturers such as HTC and LG, and so the Android revolution began in earnest. With the iPhone proving popular from launch, the devices already being built by the likes of HTC struggled to compete, and working alongside Android presented itself as a ready-made solution to what would otherwise have been a huge problem in this competitive market.

Android everywhere

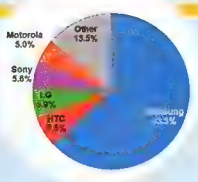
Keep in touch and stay connected all of the time with an Android Wear device on your wrist.

The logical extension for Android is to take the already mobile form of the smartphone and miniaturise the experience so that you can access the most important features from your wrist. Android Wear devices are essentially watches, but they also do much more than simply tell the time. New emails, messages and notifications will immediately be sent to the watch so that you never miss anything and you can also measure your heartbeat and steps when exercising. You can check the weather, track flights and navigate without ever touching your phone. Just like the main Android operating system, multiple manufacturers have got involved and we now have a variety of Android Wear watches available in all sorts of styles. However, the variety of such devices is fairly limited Down Under, meaning we might miss out on the best Wear has to offer.

2010
The first Google phone
Launched in 2010, the Nexus One was the first Google branded phone.

2011
Ice Cream Sandwich OS released.

2012
Three quarters
Android's market share in 2012 reached 75% worldwide.



2012
The Nexus 7
The Nexus 7 Android tablet was launched in July.

2013
KitKat announced.

The future of Android

Smartphones are merely the present tense of Android because the system could become your computing hub.

Android tablets

Android tablets are now incredibly sophisticated and can compete with the best of the competition.

Initially, Android tablets struggled to compete in terms of apps available and even the suitability of each app. Many were simply stretched to fit the larger screen and this led to concerns about usability. But app developers were relatively quick to embrace Android tablets and create apps that were worthy of the platform. Samsung and other manufacturers then jumped on board, and today, we have a vast array of tablets available that push the boundaries of what a mobile device can do. If you want a mobile experience that's close to a full computer in your hand, a tablet is the ideal way to go.

It's all too easy to view Android as a smartphone-only platform, but with Google's expertise in general web connectivity, and with online services being able to connect multiple devices together as one entity, there is a lot to look forward to. You can already send all of your films and photos to your TV using an accessory and you will soon be able to use your Android device as your entertainment hub when driving. Add to this the ability to control various devices in your home and you can start to imagine where all of this will end up.

Android does not have a direct affiliation to a desktop operating system like the iPhone (macOS) or Windows Phone (Windows), but this could potentially become an advantage. It could be able to work as a standalone platform across multiple types of devices, and with few barriers to entry, even more manufacturers will be able to develop devices and accessories that work on and with Android. Everything from lights to heating to drones could all work with the one operating system.

The history of Android continued

The story of the most-used mobile OS worldwide

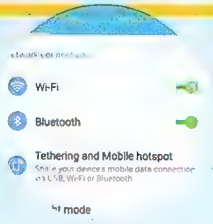
2013
Thousands of Androids
In 2013, it was estimated that there were 11,898 different Android devices available.

2013
50 billion installs
Google announced 50 billion app installs from Google Play.

2015
Marshmallow
Android M was revealed.

2017
Android Oreo
The latest Android OS is released.

2013
1 million apps
1 millions apps available in Google Play as of July 2013.



2015
On the Edge
The innovative Galaxy S6 Edge was released by Samsung in April.

2016
Android 7.0
Nougat is released allowing multiple apps to be open onscreen simultaneously.

2018
Android P
The next Android OS is teased. (We're betting on 'Popcorn'.)

Chromebook

The PC experience, simplified.

Imagine for a minute an operating system that is always protected from viruses and malware, and which you never need to update. Now, imagine being able to download from thousands of free apps that all work together and having every Google service available to you by just logging in once. It would be wonderful if it could run so efficiently that even laptops and desktops priced way below the average Windows device could run it smoothly and extremely fast. It would also be fantastic if it powered on instantly and you had a choice of devices to run it from that ranged from budget to luxury. Well, stop imagining, because that's Chrome OS, which runs on a selection Chromebooks, some of which we've reviewed in these pages.

Google Pixel 2

A new high in smartphone photography.

The Google Pixel phones run a clean version of Android that Google has not loaded up with extra apps and features. Most manufacturers like to include their own software and hardware tweaks in order to appeal to as many people as possible, but it is often the case that all of this extra baggage actually reduces the effectiveness of the device itself by clogging it up. In the Pixel 2, Google is offering pure Android with a 5-inch HD display (or 6-inch OLED for the Pixel 2 XL). While the upgraded models boast faster internals, it's the photography chops that really shine here, with the 12.2MP rear camera capable of replacing most point-and-shoot cams. The battery is huge, which means fewer charges, and the speakers aren't too shabby either.

The Pixel 2 phones are a great choice for anyone who wants to upgrade their always-on-them camera to the best of what smartphones can offer. The 2 XL looks and feels like Google's most cohesive, fully-realised attempt at a flagship phone yet. Both handsets offer a whole lot of promise today, and perhaps more importantly, continue to improve in the years to come.

Chromecast

Play Android media anywhere.

The Chromecast is an extremely well-priced accessory that plugs into the back of a TV. Your Android device can then stream films and video clips to it wirelessly to offer a much better experience than watching on a phone or tablet. On top of this, you can 'cast' apps to the TV as well and enjoy games as you would with a dedicated games console. Viewing photos is easy and the actual Chromecast app will display a series of customisable photos on the TV when you're not using it. Support for Netflix, YouTube, Optus Sport and other well-known services is included to round off a complete feature set. The setup process is simple and the system works reliably, which makes it one of the most useful accessories available for your Android device.

The future of Google

Drones

Drones may one day come to dominate the skies if Google has anything to do with it.

Drones are currently receiving a lot of attention – much of it is quite negative – but the potential future uses for this technology are actually very positive. Google has already started testing drones in Project Wing to deliver goods to customers, which would potentially greatly speed up receipt and also cut a lot of waste out of the traditional delivery systems we still use today.

It sounds bizarre, but Google has tested delivering a package using a drone, which lowers the package by a type of fishing line from 45m in the air. This type of technology would be ideal for so many of the items that we purchase currently and will likely be more environmentally friendly and safer as well.

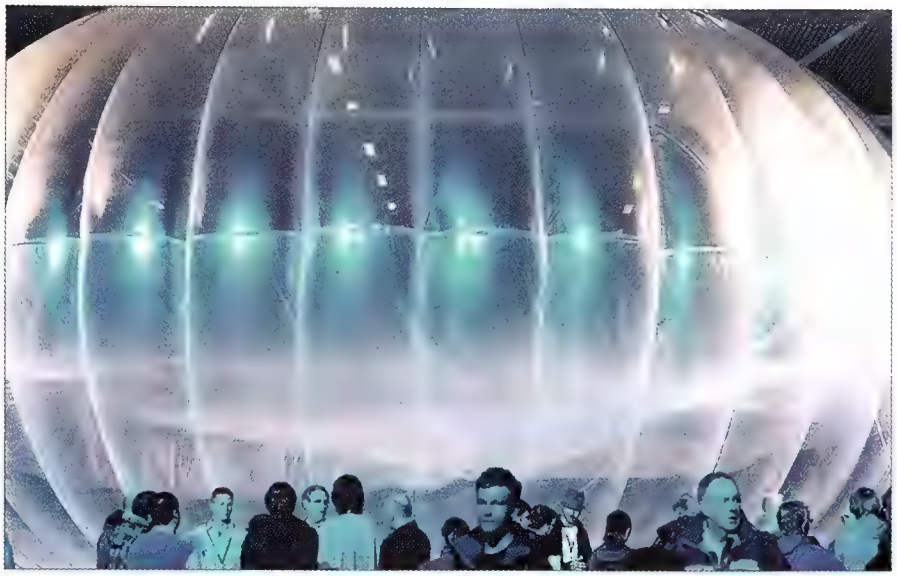
Concerns remain over safety and the privacy implications of drones, but these are common worries with all new types of technology that do things in previously unheard of ways, and eventually, these may be extinguished by the true potential. The idea that drones could provide disaster relief and deliver aid to areas in need is a captivating one. From earthquakes to floods to civil war, drones offer a level of accessibility impossible for traditional vehicles and people.

If you are wondering how drones can possibly work in such areas, a huge amount of thought has already gone into the design of each one – they can take off and land without the need for a runway and effectively offer the benefits of planes and helicopters, but in the one vehicle. Destinations can be programmed in and then the drone will deliver the aid or package without the manual intervention of a human during the process.

We can also see how many of Google's current services will help with such a journey; Google Maps is incredibly accurate and the connected nature of all the other Google services means that the potential to expand on this technology is never-ending, to the point that seeing a drone in the sky will no longer be a subject of terror, but as familiar as a cloud or bird.

Google is also working on Project Titan, which uses solar-powered drones to provide internet access from what are effectively atmospheric satellites. Like Project Loon, which is also designed to connect people in more remote areas, the potential for this technology is huge, and as both projects blossom, we will start to see safety improve alongside efficiency.

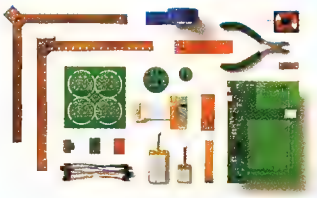
As roads become more congested and available land to build infrastructure on becomes rarer, it makes perfect sense to take to the skies. Drones can benefit our lives in a myriad of ways that we can barely imagine today.



Project Loon

Everyone could one day be connected to Wi-Fi thanks to Google's ambitious Project Loon.

Project Loon is an idea that will appeal to everyone, whether they need it or not. In many rural areas, internet connectivity can be difficult to maintain and this is especially true in some countries. Did you know that two thirds of the world's population does not currently have access to the internet? This is without doubt because the cost of providing connectivity is not small and the time needed to build the infrastructure is great. Google's idea is to send balloons into the stratosphere which will be able to send a valid connection anywhere using a vast network of balloons. It sounds daft, but it's a bit like using satellites to make phone calls, but is potentially much more affordable and thus more accessible to a greater number of people. When you think about it, Project Loon sounds completely sensible, despite the name, and could well turn out to be one of Google's most helpful projects ever.



Project Jacquard

Project Jacquard aims to turn everyday objects into interactive surfaces in an invisible way.

Some projects sound so farfetched that they cannot possibly be true, but this one is. The idea is for conductive yarns to be sewn into clothing and the like in order to create a surface that can be used to undertake tasks by touch alone. When more are added, they become sensor grids and the potential for this technology is immense. Imagine being able to act on notifications by touching your collar or tapping your trousers inconspicuously. It's all possible with Project Jacquard and especially so because work is being done to produce the technology at a large scale, which means that, one day, you may be able to pay for things and scan tickets just by walking up to a counter. With no effort whatsoever, a lot of what you do on your phone now could be undertaken just by wearing the right outfit.

Driverless cars

The dream of a driverless car is closer than ever thanks to Google's Self-Driving Car Project.

When you think of a driverless car, the immediate thoughts tend to turn to safety and not having to make any effort when navigating long journeys. These are valid thoughts and potentially beneficial, but are nothing in comparison to the scope of what Google is trying to do with its Self-Driving Car Project.

As it stands, driving is one of the most dangerous, costly and inefficient forms of travel available to us, yet millions of us would struggle without a car. If you visualise a future where driverless cars are commonplace, you can then start to put the pieces together to see where Google is going.

Cars that can communicate with each other can each find the most efficient route for every journey. They will always be aware of other vehicles and, thus, can keep accidents to a minimum, but there is one advantage that could dominate. Why would you even need to own a car in the future?

It is possible that you could tap your smartphone and a Google car will arrive to take you to work. You would not need to worry about anything. As adoption grows, we could reach the point where it is considerably cheaper to use Google cars every day for each journey than to actually own a car and deal with fuel, insurance, depreciation and all of the other associated costs that come with 'owning' a car. ■

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

BACKUP

INCREMENTAL VERSUS DIFFERENTIAL

My backup tool offers both incremental and differential backups to save on drive storage space. What's the difference?
Lewis Adam

Both types of backup take up less room because they only record the changes made since the last backup was taken. Differential backups record the changes taken since the last full backup, while incremental backups record the changes made since the last incremental backup. Incremental backups are therefore smaller than differential backups, but more prone to failure because you need all previous incremental backups, as well as the parent full backup to restore your system. Differential backups only require themselves and the full backup.

If your backup tool supports both types of backup, a typical scenario is to take one full backup a month, then weekly differential backups and finally daily incremental backups – the latter being based on the last differential backup to reduce the number of backups you need should you want to recover your system.
Mayank Sharma

SECURITY

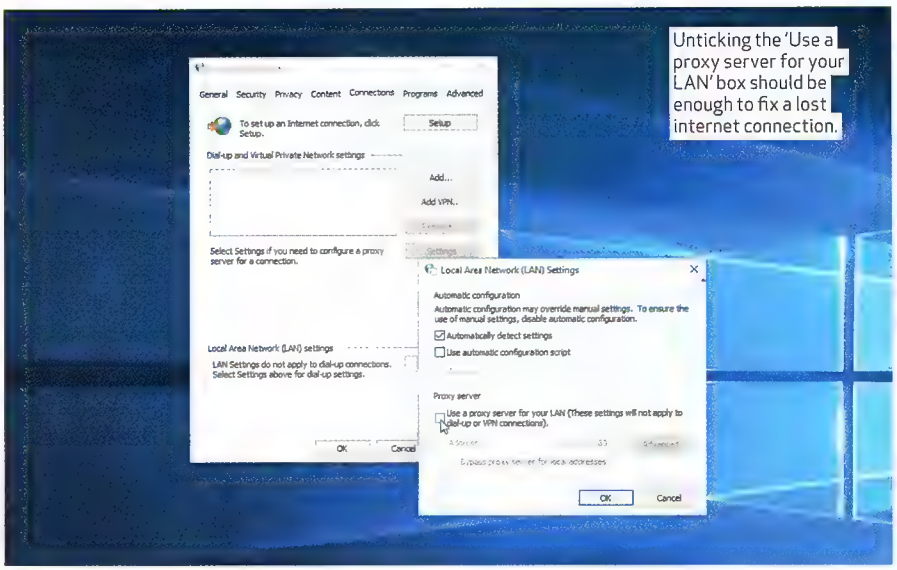
CAN'T DISABLE PROXY SETTINGS

I helped my father-in-law with his Windows 7 desktop. He kept losing the internet connection. For some unknown reason, the LAN settings box keeps getting ticked. His antivirus (Panda) did not show anything amiss. I have shown my father-in-law how to amend the connection settings manually. Do you have any suggestions for further steps I can get him to take?
Jack Porterfield

We're assuming you mean the 'LAN Proxy Settings' box, Jack. If it keeps being ticked – presumably each time your father-in-law reboots his PC – then a third-party program (potentially, but not necessarily malware) is doing this. Without knowing what's running on your father-in-law's PC, we can't provide you with specific advice.

The first thing to do is to rule out malware by performing scans with Malwarebytes Anti-Malware Free from **www.malwarebytes.com**. Assuming it comes back clean, use a tool such as Autoruns from Microsoft (look under Process Utilities at **docs.microsoft.com/en-us/sysinternals**) to identify what's loading with your PC. Google program names with 'LAN Proxy Settings' to see if any are known to amend this setting. Once identified, you can either disable the program at startup or check it for settings to prevent it from attempting to divert your connection through a proxy server.

Finally, press 'Win-R', then type `inetcpl.cpl` and hit Enter. Switch to the Advanced tab and click Reset. Tick 'Delete personal settings' and click Reset, then reboot to see if the problem has been fixed – hopefully for good.
Rob Mead-Green


Unticking the 'Use a proxy server for your LAN' box should be enough to fix a lost internet connection.
General Security Privacy Content Connections Programs Advanced
Setup
Dial-up and Virtual Private Network settings
Add...
Add VPN...
Select Settings if you need to configure a proxy server for a connection.
Local Area Network (LAN) Settings
Automatic configuration
Automatically detect settings
Use automatic configuration script
Proxy server
Use a proxy server for your LAN (These settings will not apply to dial-up or VPN connections).
OK
Cancel

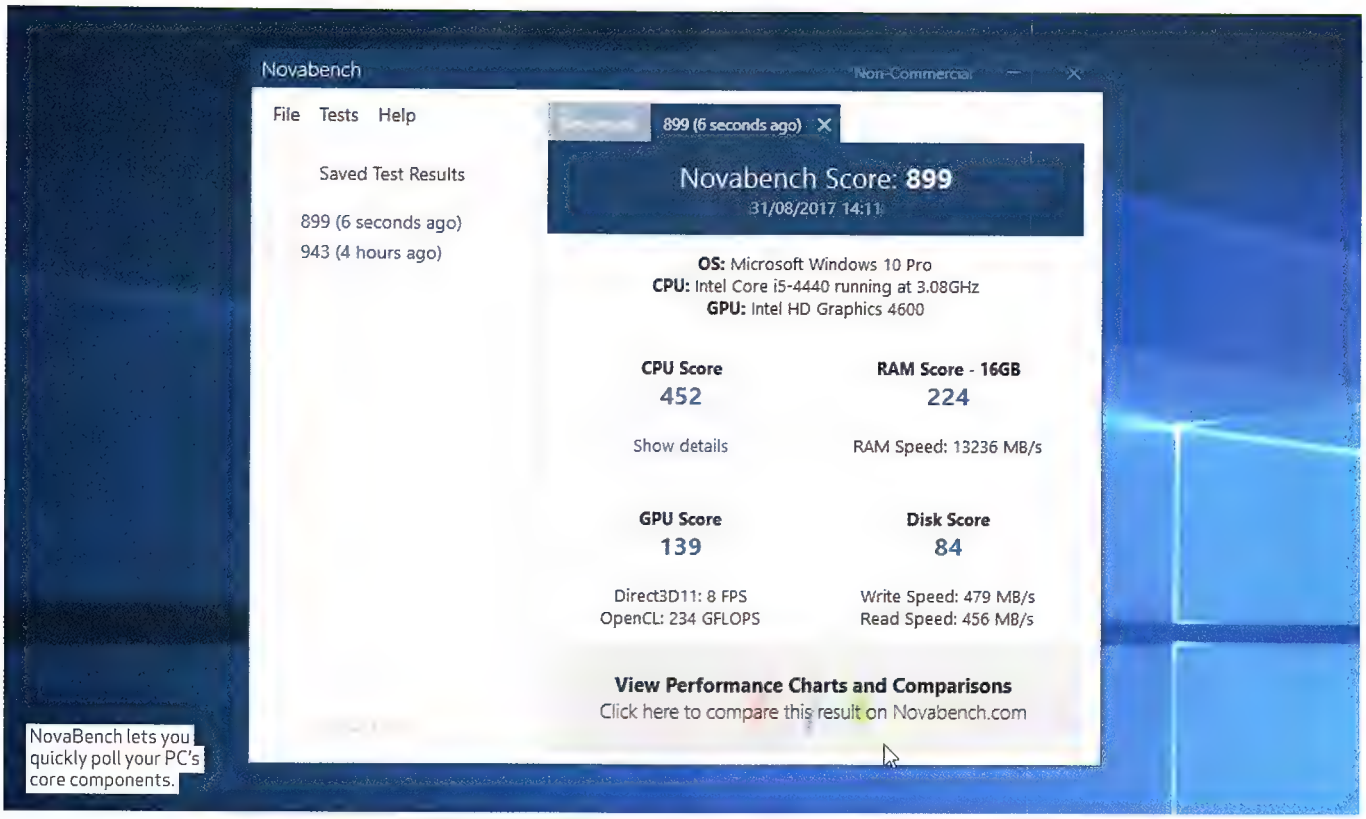
"A typical scenario is to take one full backup a month, then weekly differential backups and finally daily incremental backups."

HARDWARE

QUICK 'N' DIRTY BENCHMARK

My four-year-old PC has served me well, but I'm wondering if it's time for an upgrade. I've scoured online articles and forums, but I can't really tell how much of an increase in performance a new CPU would bring. I have a fourth-generation Intel Core i5 processor, onboard graphics and 16GB RAM — is it worth upgrading?
Geraint Powell

The jumps between Intel CPU generations isn't quite as dramatic as it once was, but there may still be value in an upgrade. You will have to factor in the cost of a new motherboard – and possibly RAM and a graphics card, too. Perhaps the best thing to do is benchmark your current setup using a free tool called NovaBench (**novabench.com**) – it only benchmarks your CPU, RAM, graphics and system hard disk, but once complete, you can submit your scores online (anonymously if you wish) and then compare them against the



NovaBench lets you quickly poll your PC's core components.

latest models. Geraint reported back that his benchmark scores revealed that the jump in speed over the preceding few years had convinced him to splash out on a new PC. And having tested the program ourselves on our similarly specified machine, we're sorely tempted to invest in a PC upgrade ourselves...
Nick Peers

SECURITY
IDENTIFY AND OPEN UNKNOWN FILES

I have been sent a file with a .pub extension. What kind of file is it, and how do I open it?
Mick Harvey

First of all, save the attachment to your PC's storage drive – never open it directly. If your security software doesn't scan it automatically, then right-click the file and opt to scan it manually. If it checks out OK, you can go about identifying it. The step-by-step guide here reveals how.

Identify file type: In Mick's case, .pub files are Microsoft Publisher documents – you can identify other files by visiting **filext.com** and typing the file extension into the Google Custom Search box in the top right-hand corner, or try a wider Google search.

Locate compatible app: If the parent program in question isn't available for free, type it into **alternativeto.net** to source alternatives. Microsoft Publisher isn't free, but Scribus (**www.scribus.net**) is an open-source desktop publishing tool that can open .pub files, however.

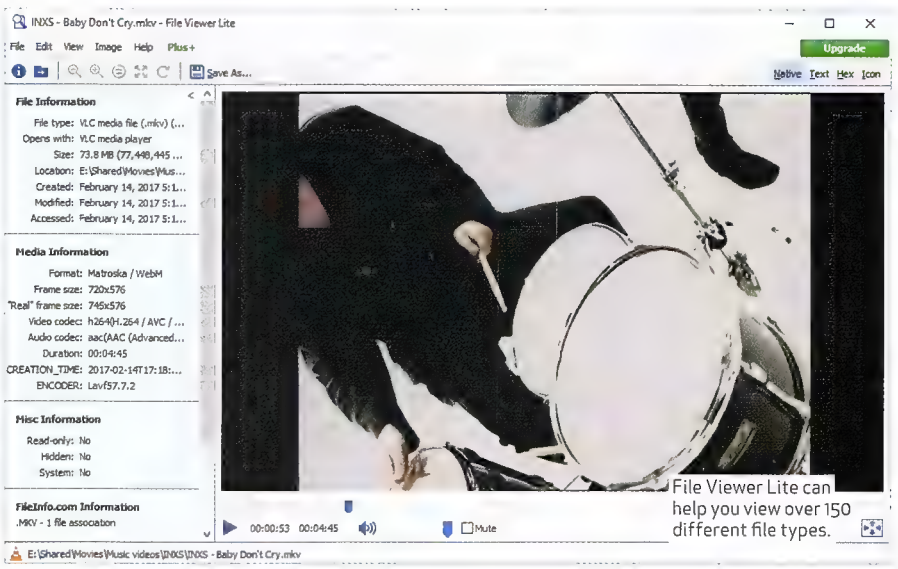
Try a file viewer: If you can't locate a suitable app, go hunting for a free file viewing tool. Avoid Free File Viewer (Malwarebytes blocks it), and instead try File Viewer Lite from **windowsfileviewer.com**, which can handle over 150 different file types.

Other solutions: Other options include trying free online file conversion tools such as Zamzar (**www.zamzar.com**) or replying to the sender and explaining the situation and asking them to provide the file in a different format – a PDF is a good option if it's available.
Ian Sleightholm

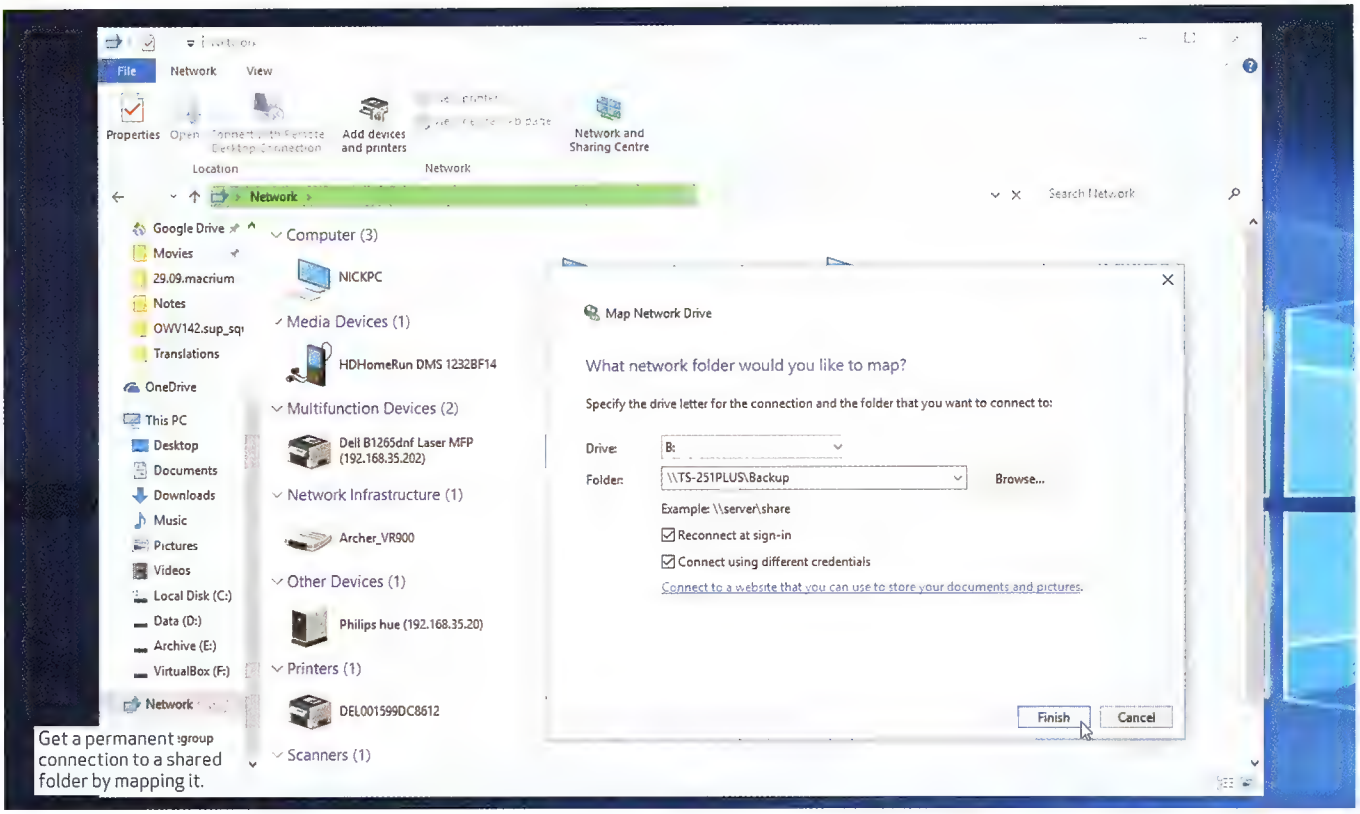
WINDOWS
ERROR MESSAGE ON SHUTDOWN

Both my wife and I are getting the same error when we shut down our PCs, running Windows 7 and 10, respectively. It's linked to BitDefender Threat Scanner, and it reads: 'A problem has occurred in BitDefender Threat Scanner. A file containing error information has been created at C:\WINDOWS\TEMP\BitDefender Threat Scanner.dmp.' Can you help us resolve this problem please?
John Wallis

The error is a very well-known one, and is linked to a corrupt file in Spybot Search & Destroy. To its credit, BitDefender was quick to issue a patch that should resolve it. You need to



File Viewer Lite can help you view over 150 different file types.



know which Windows system type (32-bit or 64-bit – press 'Win-Pause/Break' if you're not sure), and then download the appropriate patch. The 32-bit version is available from: **www.bitdefender.com/files/KnowledgeBase/file/BDRepair_Tool_win32.exe**

While the 64-bit version is here: **www.bitdefender.com/files/KnowledgeBase/file/BDRepair_Tool_x64.exe**

Once you have applied the patch, the corrupt file should be fixed and the error message cease.

Cat Ellis

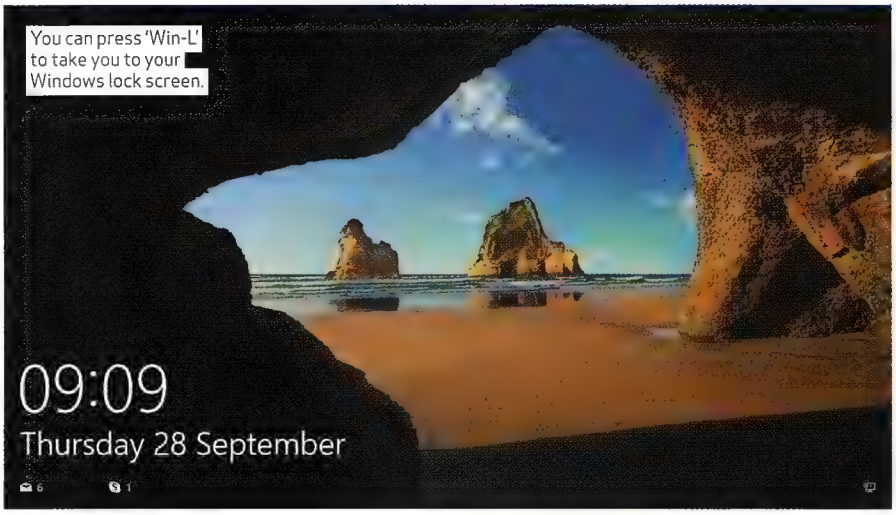
NETWORKING

NETWORK DEVICES DON'T SHOW UP

I seem to have a strange issue where File Explorer doesn't show all of the attached network devices on my PC, making it impossible to access — among other things — my two Synology DiskStation drives and a Surface tablet. Can you advise please?

Jorgen Gullestrup

We've been plagued with similar problems ourselves – sometimes, shared resources immediately show up in File Explorer, while other times, they can take 5–10 minutes to appear, if at all. Thankfully, there are two workarounds you can usually employ to bypass this problem. The first is to open File Explorer and simply type '\\devicename\' folder (such as '\\DiskStation\Shared') or the device's IP address ('\\192.168.0.4\Shared') to directly access a shared folder.



Using the IP address works when the device name isn't recognised. Related to this, you can also map a drive letter to a specific network resource or folder, which ensures that the shared folder is always accessible even after Windows starts. You may occasionally get an error about the drive not being found, but this is resolved by waiting a minute or two. To map a drive letter, right-click the Network icon in the left-hand pane of File Explorer and choose 'Map network drive'. Choose your drive letter, then click Browse (if the shared folder or drive is currently present) or type it in manually again following the syntax above. Leave 'Reconnect at sign-in' ticked, then tick 'Connect using different credentials' if you log on with a different username and password.

Nick Peers

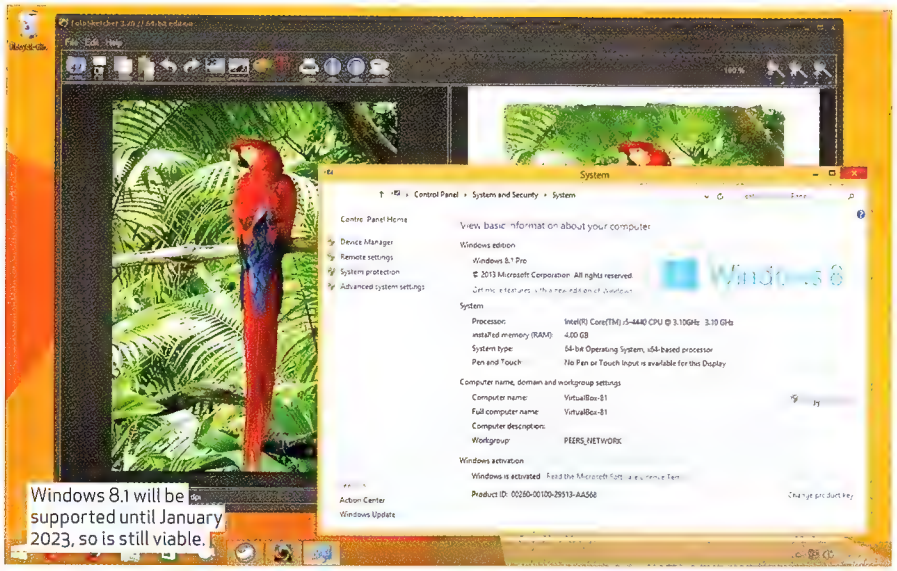
LINUX

KALI CONUNDRUM

I am having problems trying to get a Kali Linux and Mac OS X dual boot on my MacBook, as when I installed Linux, there was no Wi-Fi chip found. I did some research and found it was a common problem. I managed to get a USB to Ethernet working with the internet, but when I use `apt-get install Thenameofthedrive` ***, it says 'package not found' and the same error occurs when I try installing different applications that had worked for me previously. I found that adding some repositories might help but using*** `apt-add-repositorie/s` ***, it says 'command not found'.***

Paul Fawbert

The wireless network adaptor in the MacBook Pro is not supported by Linux


System
Control Panel › System and Security › System
Windows 8.1 Pro
© 2013 Microsoft Corporation. All rights reserved.
Windows 8
Windows 8.1 will be supported until January 2023, so is still viable.

"When you lose internet access, the first thing you should do is verify it's not a configuration issue using step-by-step guides and troubleshooters."

without additional firmware. This is not included with the Linux distribution for licensing reasons but can easily be added with the command:

```
$ sudo apt-get install firmware-b43-installer
```

You do not state which year of Apple MacBook this is, but that package should work for most Broadcom BCM controllers, as used by the MacBook and many others. If after rebooting, the wireless connection is still not available, you may need to use the broadcom-sta package instead. To switch to that, run:

```
$ sudo apt-get remove firmware-b43-installer
$ sudo apt-get install broadcom-sta
```

Having both installed can potentially cause conflicts, so it's best to try one at a time. It is a bit 'chicken and egg' when you need a network connection to install a network driver, but you managed to neatly sidestep that with your use of a USB Ethernet adaptor. The apt-get utility needs the precise name of the package to install, although it can offer some guesses if the name is almost right. If you are unsure, use the search option first:

```
$ sudo apt-cache search search_term
```

The command to add a repository is:

```
add-apt-repository
```

Not "repositorie" but it isn't installed by default on Ubuntu-derived distros. You can install it with:

```
$ sudo apt-get install python-software-properties
```

It is also possible to add repositories by editing /etc/apt/sources.list; `add-apt-repository` is a convenience function, usually used for adding PPAs to sources.list. Kali advise against adding extra repositories, warning that it could break the distro, it has a list of recommended repos at **docs.kali.org/general-use/kali-linux-sources-list-repositories**. Distros go to a lot of trouble to make sure that all the software they provide plays nicely together, adding random PPAs breaks this cycle of QA testing, introducing untested software into the mix. This is particularly risky on a distro like Kali, where security is of utmost importance. Don't let your first stumbles put you off, it is great to see someone thinking of original solutions.
APC Team

WINDOWS
CHANGE TIME FORMAT ON WELCOME SCREEN

Why does my Lock screen show a 12-hour clock when I start Windows, but a 24-hour clock when resuming from sleep or a locked computer? How can I make both settings match each other?
Steve Cox

This problem occurs because the Lock screen at startup takes its settings from the system account, not your personal account. Read on to discover how to bring both settings into sync.

Locate settings to correct: Click 'Start › Settings' and navigate to 'Time & language › Region & language'. Once there, click 'Additional date, time & regional settings' to open the Control Panel. Then click 'Change date, time or number formats' under Region.

Change Lock screen settings: From the Formats tab, set the 'Short time' format to your chosen setting, which affects the time format shown on the Lock screen: the 'H' and 'HH' options set a 24-hour clock, 'h' and 'hh' set a 12-hour clock. Click Apply when you're happy with your choices.

Verify settings: Press 'Win-L' on your computer keyboard to verify the Lock screen now shows the time as you want it to appear. As things stand, this will only affect it when you sleep or lock your PC – the Lock screen at startup is linked to the main system account.

Set start-up lock screen: Once you're happy with your settings, switch to the Administrative tab and click 'Copy settings...' A new pop-up window will appear. Tick 'Welcome screen and system accounts' and click OK to complete the switch. Reboot to test.
Ian Sleightholm

HARDWARE
UPDATE KILLED MY NET CONNECTION

On Saturday last, my Acer Z3-600 was automatically updated and now I can't access the internet. Acer originally told me that the drivers needed updating, but the link it provided didn't work. Now I'm told my machine isn't eligible for the Creators Update so I must reinstall Windows 10 or hope Microsoft issues another update. This is a disgrace!
Paul Latham

We feel your pain, Paul. That said, I think Acer rather than Microsoft is culpable here – four years is no time to drop extended support for a product. However, just because Acer doesn't officially support your all-in-one PC doesn't mean it's not going to continue working. When you lose internet access, the first thing you should do is verify it's not a configuration issue using the step-by-step guides and troubleshooters highlighted at the Microsoft Help article here: **support.microsoft.com/help/10741**. If you suspect a driver problem, then the latest driver for your PC's RTL8168 wireless chip can be downloaded from **www.realtek.com** – click the Realtek PCIe GBE Family Controller Series Drivers link. If it's already installed, rolling back the driver to the previous version as outlined in the Microsoft Help article may provide the cure. If neither option works, you may have to bite the bullet and reinstall Windows 10 from scratch, or even roll back to Windows 8.1.
Alex Cox

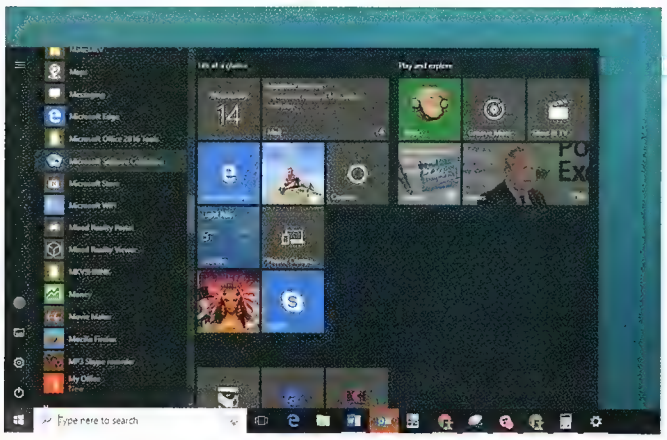
Remove Windows 10's pre-installed apps

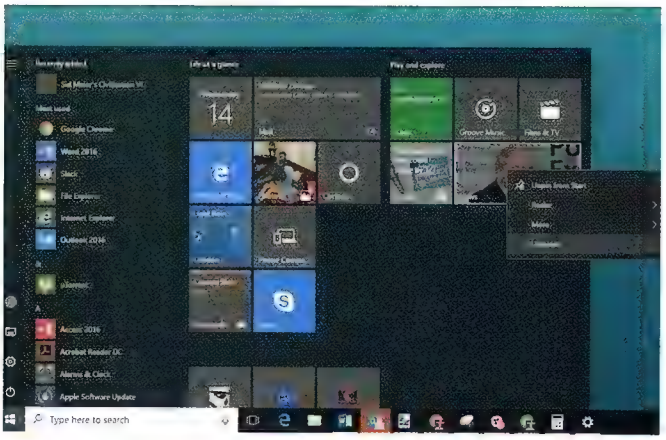
Windows 10 comes with a range of pre-installed apps that you may not actually want to use. Matt Hanson explains how to get rid of them.

Windows 10 comes with a number of apps already installed, and while these are designed to help you get started with your new laptop or PC as quickly as possible, you may find that you will never use many of these apps. So rather than keeping them, and having them clog up your Start menu and take up precious space on your PC, you can uninstall them.

In this guide, we'll show you how to find all the pre-installed Windows 10 apps, and help you decide which ones you don't need. We'll then show you how to safely remove them from your machine. Also, if you've recently bought a PC or laptop, then you may find that the manufacturer has also installed some apps of their own that you will likewise never use. A good program to remove those apps quickly and easily is PC Decrapifier, which can be downloaded for free from **www.pcdecrapifier.com**

Remove pre-installed Windows 10 apps



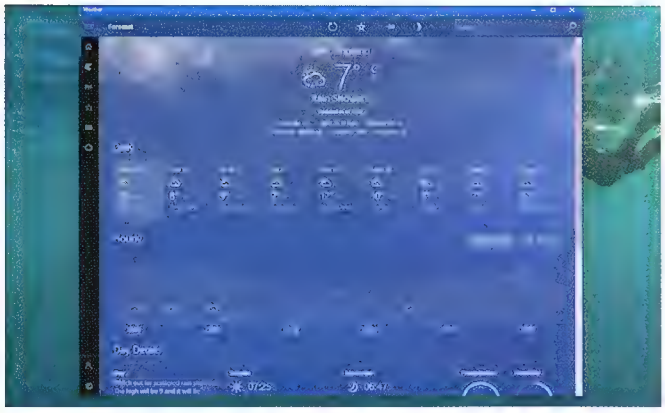


1 WHAT APPS CAN YOU EASILY UNINSTALL?

When you first use Windows 10, you'll see a number of pre-installed apps. Many of these can be removed quite easily, while others are more complicated. The easily-uninstalled apps are: Get Started, Get Skype, Get Office, Microsoft Solitaire Collection, Money, News, Phone Companion, Sports, Optional Features, Windows Media Player and Windows DVD Player.

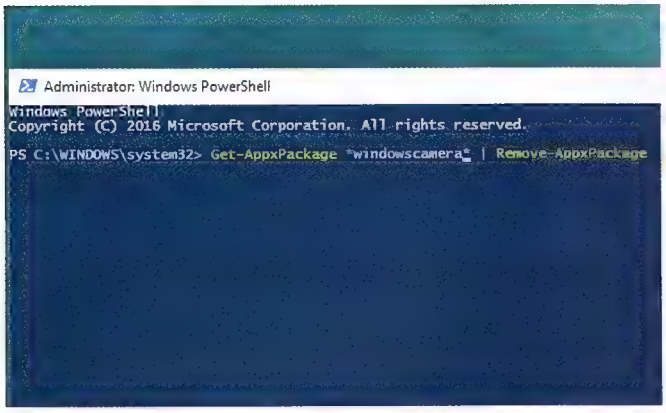
2 QUICKLY UNINSTALL THESE APPS

To remove the apps listed in Step 1, all you need to do is find their entries in the Start menu, right-click their icon, and select Uninstall. A small message will appear letting you know that the app, and any associated data, will be removed from your PC. If you're happy to proceed, click Uninstall once again. The selected app will then be deleted from your device.



3 OTHER PRE-INSTALLED APPS YOU CAN REMOVE

There's also a number of pre-installed apps in Windows 10 that can be removed as well, but the process is a little more complicated. This is because these apps are more tightly integrated into the operating system. The apps include: Calculator, Calendar, Mail, Camera, Maps, Movies & TV, People, Photos, the Microsoft Store app and Weather.


Administrator: Windows PowerShell
Windows PowerShell
Copyright (C) 2016 Microsoft Corporation. All rights reserved.
PS C:\WINDOWS\system32> Get-AppxPackage *windowscamera* | Remove-AppxPackage

5 REMOVING AN APP

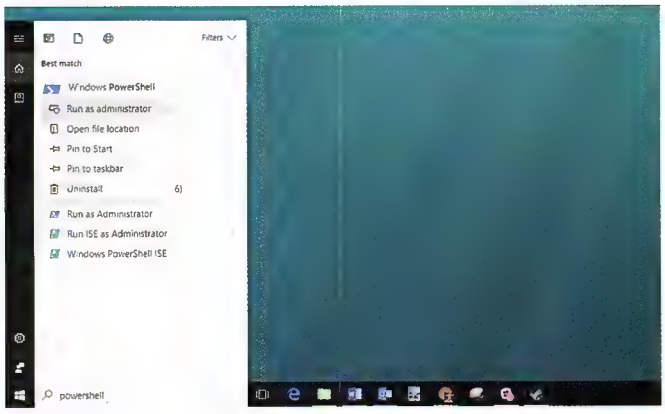
With the PowerShell window open, you'll now need to type in the following code to remove apps:

```
Get-AppxPackage *appname* | Remove-AppxPackage
```

If you want to remove the Camera app, for example, you'd type "windowscamera" in place of 'appname'.

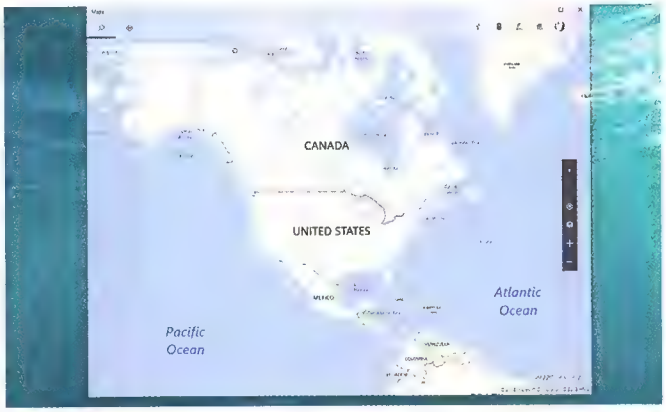
7 USE THIRD-PARTY SOFTWARE

If you're not confident about using Windows Powershell to remove apps, try 10AppsManager from **www.thewindowsclub.com/10appsmanager-windows-10**. Click 'Download File', and when the ZIP file has downloaded, open the folder and click the the EXE file. A window will appear and you can click the icon of the app you want to uninstall.



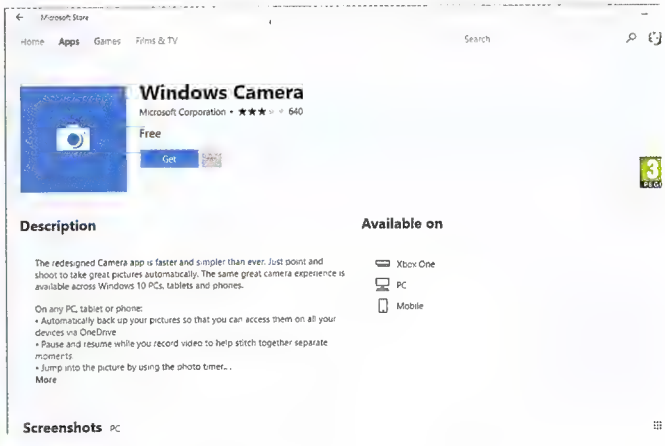
4 USE POWERSHELL TO REMOVE THOSE APPS

For the trickier-to-remove apps, you'll need to use the Windows PowerShell. This is a powerful tool that should only be used if you're confident. To open PowerShell, type "powershell" into the search box in the Taskbar. When 'Windows PowerShell' appears, right-click it and select 'Run as administrator'. A window will appear that looks similar to the command prompt.



6 CODES FOR OTHER APPS

Here are some useful codes: 3D Builder (3dbuilder), Alarms and Clock (windowsalarms), Calendar and Mail (windows communicationsapps), Calculator (windowscalculator), Groove Music (zunemusic), Maps (windowsmaps), Movies & TV (zunevideo), OneNote (onenote), People (people), Photos (photos), Store (windowsstore), Voice Recorder (soundrecorder), Xbox (xboxapp).



8 REINSTALL APPS

You now know how to get rid of unwanted apps! If you change your mind and want to reinstall an app you've deleted, you can do this by opening the Microsoft Store and searching for it. When you find the app, click it, then click Get. Of course, this assumes that you haven't deleted the Microsoft Store app! If you have, you'll need to use a Restore point to get it back.

View, edit and annotate PDFs in Microsoft Edge

The Fall Creators Update enables you to view, edit and annotate PDFs in your web browser – no third-party apps required, says Ian Evenden.

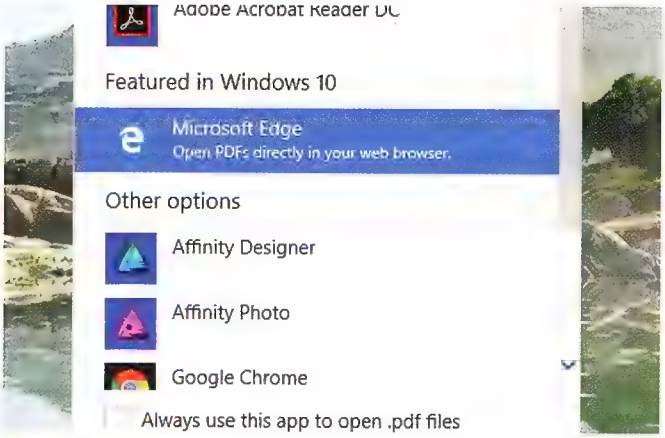
Reading PDFs on your PC sounds pretty basic – all you do is install Adobe Reader, and then just open every PDF file you get with that app.

Well, it doesn't have to be like that. You don't need to install a third-party app, you can use one that came with your PC. Microsoft Edge's PDF reading capabilities got a boost in the Fall Creators Update, and it's now a very capable app for those times only a PDF will do.

PDFs are easy to create but not to edit, and since they embed the fonts and graphics used to create their source document, you can be sure that what you're seeing is just as the original author intended.

Using Edge, you can read, annotate and even draw over PDFs, before saving your notes to send on or reopen later. You may think Edge is just a web browser, but it has more uses than that, as we will see.

View those PDFs, and annotate too



1 OPEN IN EDGE

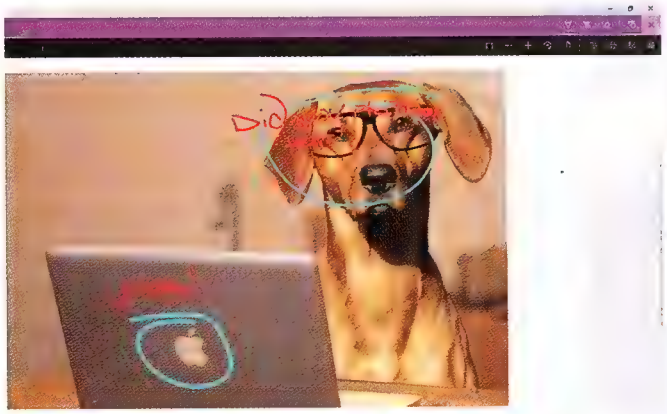
If you often deal with PDFs, it's possible that Adobe Reader is installed on your PC and will open if you double-click a PDF. To open a PDF in Edge, right-click the file, choose 'Open with > Edge'. If you like Edge and want to open PDFs in it every time, right-click the file, select 'Open with > Choose Another App'. Select Edge, then tick the 'Always use this app...' box.

2 HIGHLIGHT TEXT

One thing you can do with a PDF is annotate it, highlighting part of it and leaving your opinion in a pop-up note to send back to the document's creator. While PDFs aren't directly editable, you can save these notes back into the document. To leave a note, select some text then choose 'Add a note' from the pop-up menu that appears. When you're done, click the tick.

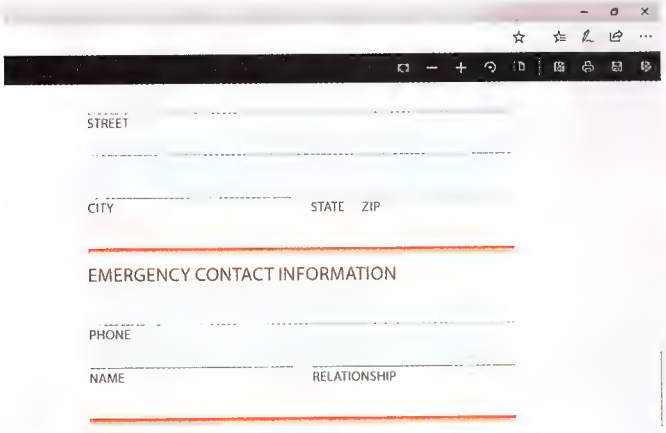
3 CHOOSE A HIGHLIGHT COLOUR

Click the 'Add notes' button at the top right of the interface to open a purple menu bar containing your note-making options. The option second from the left (a yellow pen nib with an 'A' next to it), enables you to change the colour of your highlights, if you want to make some look different to others. The colour you choose also affects the colour of any notes you attach.



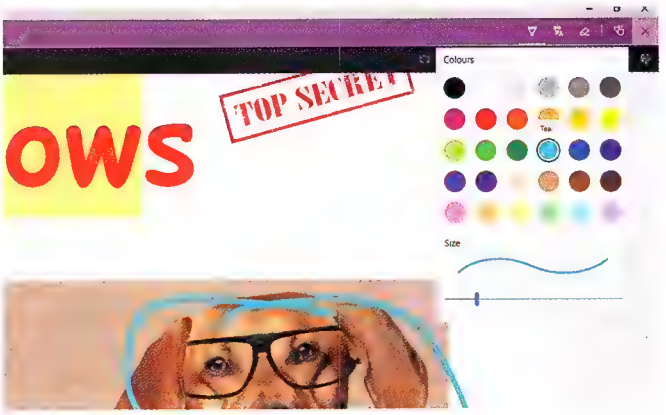
5 AN ANNOYANCE

One thing Edge needs is the ability to attach notes to more than just highlighted text. As it stands, if you want to point out a mistake in an area covered by graphics or a photo, rather than highlightable text, you need to draw the note on rather than opening a text window. The ability to leave text notes anywhere would have extended Edge's capabilities in this area hugely.



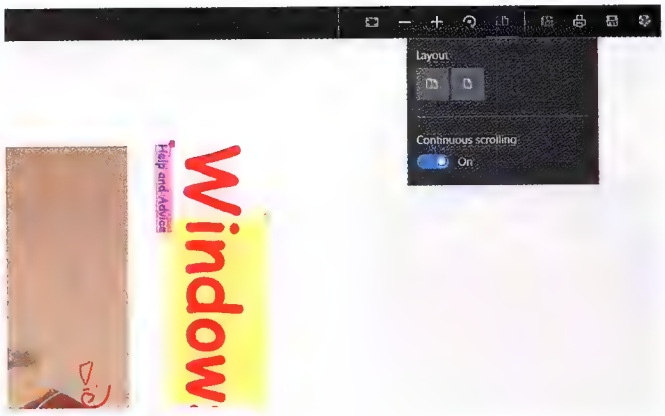
7 FILL IN FORMS

A form in PDF format that can be emailed and returned is becoming a popular way of gathering data, especially since it can be saved and referred back to. Once you've filled in a form using Edge, use 'Save as' to save it under a new name for it to remain editable. To make a non-editable version, print it as a new file using the print dialogue, but choose PDF instead of a printer.



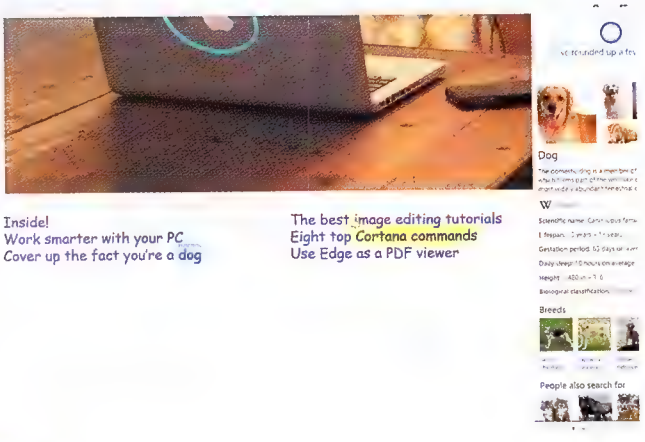
4 DRAW ON YOUR PDF

You can doodle all over a PDF with either your mouse or a touchscreen interface — make sure the Touch Writing button (top right) is selected, then drop down the Ballpoint Pen menu to choose the colour and thickness of your doodle. Then draw anywhere on the PDF you want. If you've got a pen interface, you can write notes this way, but it's very hard to do with a mouse.



6 LAYOUT AND ROTATION

If your PDF has multiple pages, and is perhaps divided into two-page spreads, you can view it either that way or one page at a time. You can also rotate pages through 90°, as well as zoom in and out. The controls are in a black menu bar that drops down from the top of the interface when you click somewhere on your PDF, along with other useful options.



8 CORTANA

Like everything in Windows 10, you'll find Cortana's silicon tentacles laced through Edge. Highlighting text in your PDF lets you ask the AI assistant about it, and if she's really stuck, she'll perform a Bing search. Whether or not she knows or has to search, the information appears in a sidebar on the right, which can be dismissed, pinned for later or explored to open other websites.

Organise macOS's Launchpad

Make Launchpad work better by adding folders and Home screens.

Launchpad is another great feature, introduced by Mac OS X Lion, mirroring the functionality of Springboard on iOS. Springboard is the app launcher that you'll find on your iPhone or iPad, which allows you to arrange icons for each of your apps across many Home screens and, if desired, nested into folders you create yourself.

Every app you install appears automatically on your Home screen, and the same applies for apps installed on your Mac, with each finding its way onto your Launchpad. However, unlike the iPhone, the Mac App Store isn't the only means of getting apps onto your Mac, so how do you add, remove and control these non-App Store apps?

We've collected together a series of hints and tips to help you get the most out of Launchpad, including taking control of those apps you don't want to appear. We'll also show you how to spice up its appearance with custom icons, organise your apps and navigate around Launchpad quickly. Read on to find out how to tame your macOS Launchpad into submission.

Organise your apps

Control Launchpad to keep things in their rightful place.

1 GESTURES
Swipe with two fingers to slide between pages of apps, hold down Opt/Alt to automatically enter the organisation mode (where the apps quiver and allow you to move them around). Do a four-finger reverse pinch to exit Launchpad quickly, or tap Escape on your keyboard.

2 HIDE APPS
Hide unwanted apps by installing the free System Preferences add-on, which is available from **chaosspace.de/launchpad-control**

3 FOLDERS
Arrange your apps into folders by clicking and dragging one app onto another. This will create a folder that is automatically named for you. Rename the folder by clicking on its title and typing over the highlighted text.

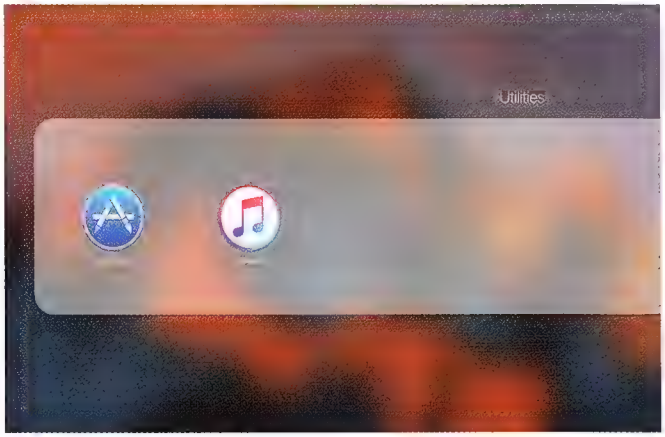
4 PAGES
Each dot represents a different page of apps inside Launchpad. You can navigate between pages by swiping with two fingers, or quickly jump to a page by clicking on the relevant dot to save time.

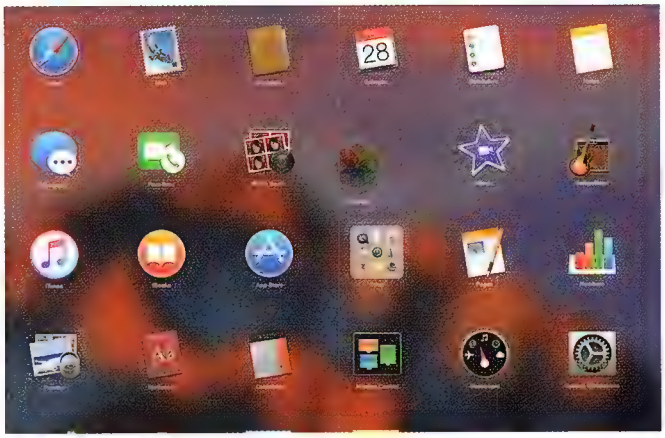
Removing non-App Store apps

One of the limitations of Launchpad is its reluctance to let you remove apps that didn't originate in the Mac App Store. Unless you're brand new to the Mac platform, it's very likely that you've got a reasonable collection of apps that didn't come from here, but when you enter 'quiver mode', these apps don't have a remove option, so how do you get rid of them? There are a couple of solutions: the easiest is to simply drag all your undesired apps into one folder and hide it on a screen all of its own at the end of the screens. The second is to install the preferences pane found at **chaosspace.de/launchpad-control**. This lets you untick apps you don't want to appear, removing the link from Launchpad, but not the app from your computer.

Launchpad

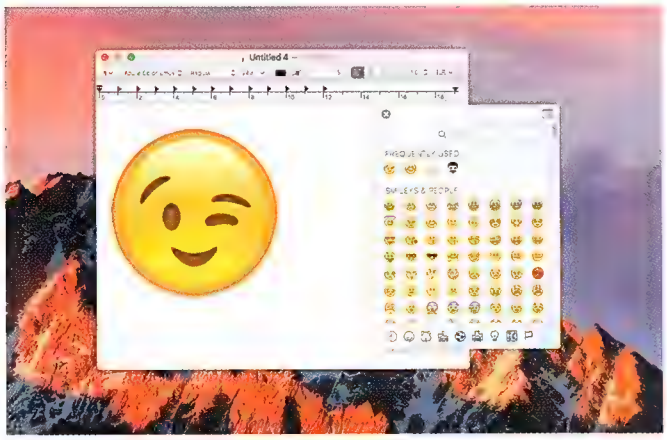
Make Launchpad your own





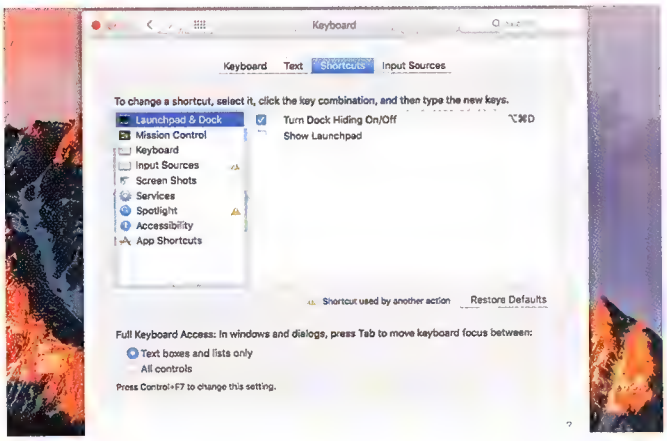
1 CREATE FOLDERS
Drag one app icon onto another. As you release your mouse, the two apps will form a folder, which will be named automatically. Rename the folder by clicking the title.

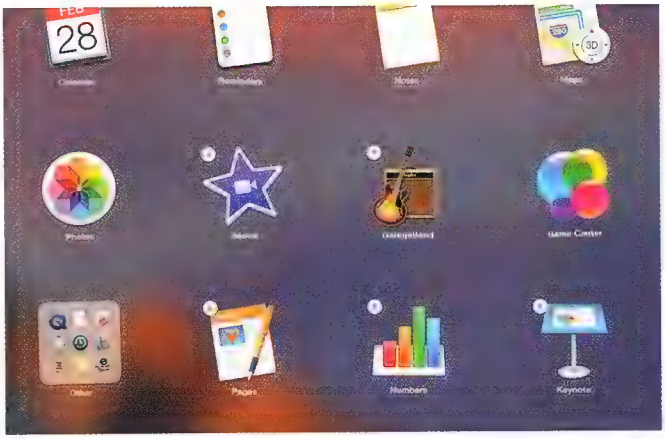
2 MOVE YOUR APPS
You can easily re-order your apps within your Launchpad simply by clicking and holding on an app icon, then dragging it into position.



3 LIVEN IT UP
Use Emoji icons in your folder names by opening a new TextEdit document, choosing 'Edit > Emojis & Symbols', and copy-pasting to the Launchpad.

4 HIDE UNWANTED APPS
Hide unwanted apps by installing the System Preferences add-on, detailed in the boxout opposite.



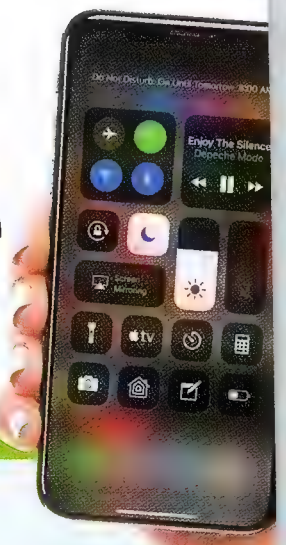


5 SET UP A SHORTCUT KEY
Choose 'System Preferences > Keyboard', and add a shortcut key into the Keyboard Shortcuts tab.

6 DELETE APPS
To remove apps from your Launchpad, click and hold on an app icon until all the icons quiver. Once they're shaking, click on the 'X' next to an app.

Configure & customise iOS's Do Not Disturb mode

Alan Stonebridge shows how you can take a well earned break from the pressures of work and life.



Do you crave time away from the hustle and bustle of daily life? Phones and tablets enable us to be always online, but the boundaries between our digital, work and personal lives are increasingly blurred, meaning we get fewer opportunities to switch off from the distractions that our devices bring, short of turning them off.

Apple's solution to this is Do Not Disturb – a feature which, when activated, silences all notifications, alerts, incoming phone calls, and messages for a set period of time or until you deactivate it.

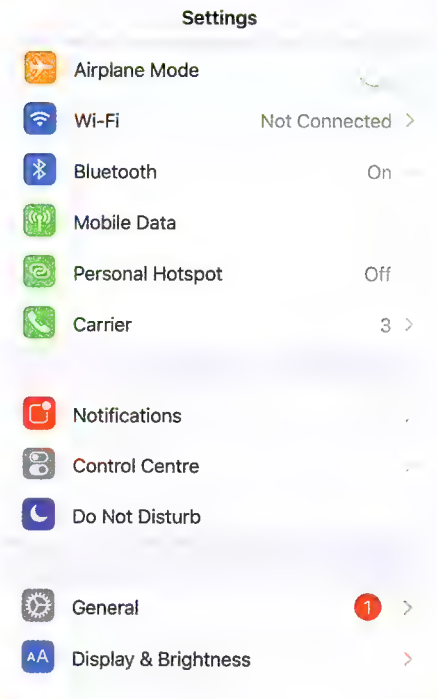
Don't worry, though; you won't miss a thing. Your iPhone collects all of the alerts together, while your phone stays dark and silent.

Undisturbed Mac

Do Not Disturb is also a feature of macOS and can be useful as it enables you to focus on a task without notifications distracting you by appearing at the top right of your screen. The fast way to toggle it is to hold Alt and click the menu bar's rightmost icon; it will dim when Do Not Disturb is active. Do Not Disturb will stay on until you manually turn it off, or else until midnight or the next scheduled time to turn off (you can change these settings in Notifications Preferences).

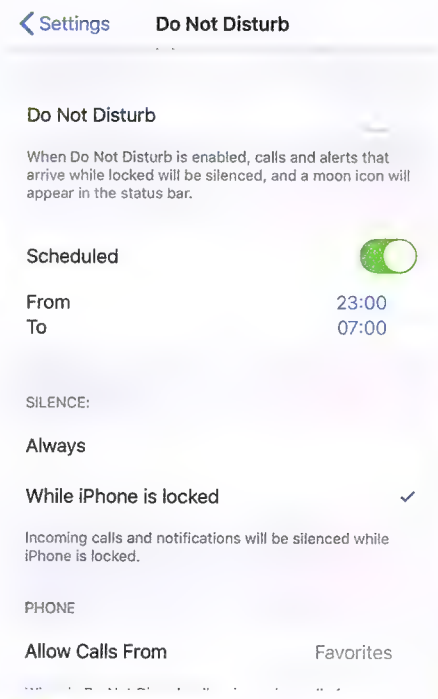
How to

Work with Do Not Disturb



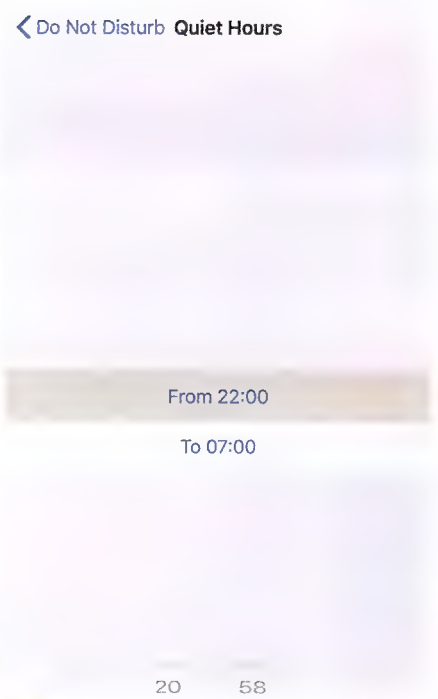
1 ACTIVATE DO NOT DISTURB

Open Settings and tap Do Not Disturb. Use the topmost switch to turn on the feature; on most iOS devices, a crescent moon is shown in the status bar when Do Not Disturb is active.



2 SCHEDULE QUIET TIME

You can turn on Do Not Disturb from Control Centre by tapping the moon icon. You can also have it activate automatically during certain hours: turn on 'Scheduled' and tap the From/To box.



3 TURN IT ON

A pair of rotating dials will appear, on which you can swipe up or down to set an hour and minute. The From row will be selected; use the dials to set the time when Do Not Disturb will turn itself on.

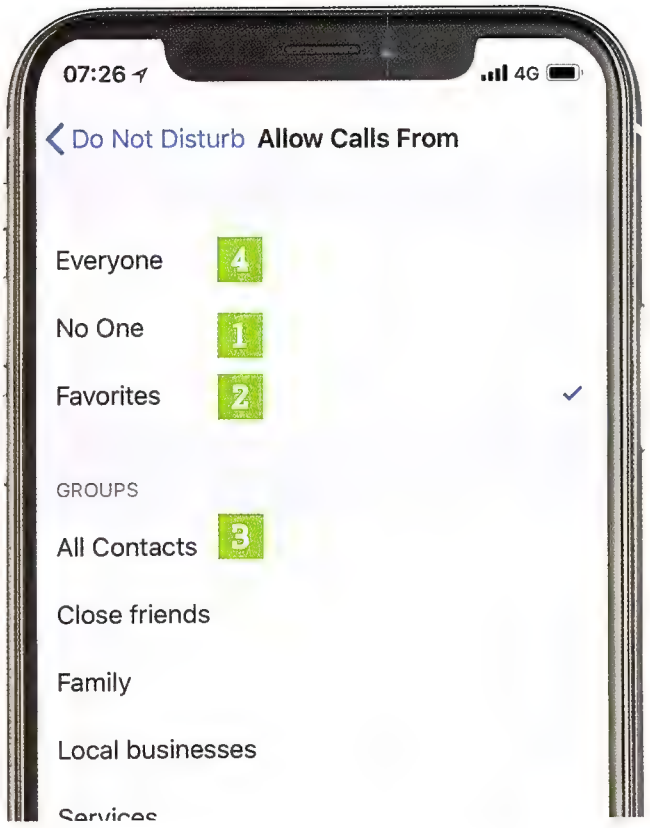
Selectively allow calls

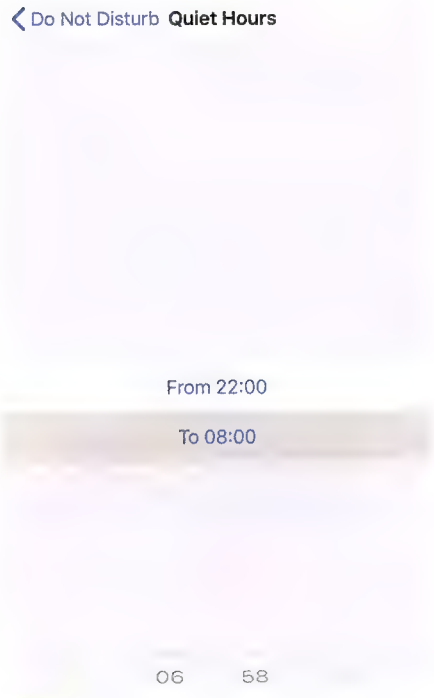
1 BLOCK ALL CALLS
If you really want a bit of peace and quiet with no interruptions — and no exceptions — tap the No One option to silence all incoming calls.

2 ALLOW FAVOURITES
You can add Contacts to your Favourites list in Contacts. If you'd like calls from this group to get through to you even if Do Not Disturb is active, tap Favourites.

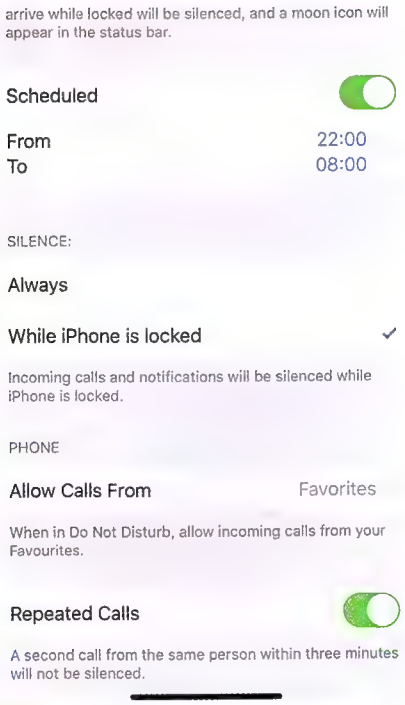
3 ALLOW GROUPS
If you'd like a specific group of contacts to be able to reach you, tap that group's name in the list below; groups can be managed on a Mac or at iCloud.com.

4 ALLOW ALL CALLS
To stop notification banners and alerts and number badges on app icons from distracting you, but still receive calls, choose Everyone.

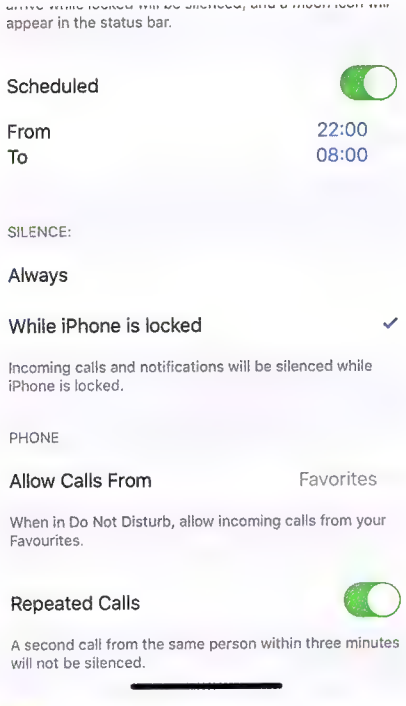




4 TURN IT OFF
Tap the To row and set the time that you want Do Not Disturb to switch off. At that time, your device will return to normal, with your usual notifications and sounds (change these in 'Settings > Notifications').


arrive while locked will be silenced, and a moon icon will appear in the status bar.
Scheduled
From
22:00
To
08:00
SILENCE:
Always
While iPhone is locked
Incoming calls and notifications will be silenced while iPhone is locked.
PHONE
Allow Calls From
Favorites
When in Do Not Disturb, allow incoming calls from your Favourites.
Repeated Calls
A second call from the same person within three minutes will not be silenced.

5 TWEAK SILENCE
Go back to the top level of Do Not Disturb's settings. Under Silence, there's a choice: have Do Not Disturb silence all alerts, or only when your device is locked; so they'll play when your attention is on screen.



6 ALLOW CALLS
You may have some people who you always need to be able to get through. Turn on 'Repeated Calls' to allow a second call from the same person to get through if it comes within three minutes of the first one.

How to use gestures to navigate on iPad

Learn the many ways you can control your iPad using the power of your fingers.

"Enable Multitasking Gestures by going to Settings, then General, and tapping the slider."

1 TAP

Tapping is the main way you will navigate your iPad. To open an app, you must tap it from your Home screen, for example. You'll mainly be tapping the iPad to select things like web links in Safari, songs in Music or pictures in Photos. You'll also need to tap to type on the on-screen keyboard when it appears in numerous apps such as Mail, Messages, Reminders and Notes.

2 SCROLL

Scrolling is when you drag your finger up or down the iPad's screen. This is most useful when the iPad can't fit all the information on one screen, so you need to slide your finger up to move the screen down and vice versa. This is most common in apps like Safari, Notes and, depending on the size of your collections, Music and Videos.

3 SWIPE

Where scrolling is vertical, swiping is horizontal — you just need to move your finger from left to right or vice versa. Once you start filling your iPad up with apps, you'll need to swipe to switch between pages of apps on the Home screen. It's also needed to flick through the pages of your ebooks in iBooks and your magazines in Newsstand.

4 DRAG

Dragging is when you tap and hold your finger on the iPad, then drag it anywhere else on the screen. It's essential when moving apps around on the Home screen. Tap and hold on an app until all other apps start wobbling. You can now drag it to its rightful place on the Home screen. It's rarely used in other native apps, but common in third-party games.

5 PINCH

Widely used among built-in and third-party apps, the pinch is a very useful gesture. To perform it, place two fingers on the screen and bring them together. It won't do anything on the Home screen, but in many apps, including Photos and Maps, it zooms out the display. The more distance between your two fingers, the larger the zoom.

6 SPREAD

The spread is essentially the opposite to the pinch: rather than bringing two digits together, you spread them apart. The effect is also the opposite, as rather than zooming out, you zoom in instead. This is particularly useful in Safari, when perhaps you need to zoom in to read particularly small text; or Photos, when you want to inspect an image close-up.

7 FIVE-FINGER PINCH

After enabling Multitasking Gestures in the General section of Settings, you will be able to perform a four or five-finger pinch. This works in most apps, and it will automatically take you back to the Home screen. To perform the pinch, place all five fingers on the iPad screen and then bring them all towards a single point.

8 FIVE-FINGER SCROLL

To access your recently used apps quickly, place all five fingers on the iPad screen and then move them all upwards. This will reveal the multitasking bar. From here, you can choose a recently used app to use by tapping on it. If you tap and hold the app, you will be able to remove it from the multitasking bar by tapping the red icon.

9 FIVE-FINGER SWIPE LEFT/RIGHT

To switch between apps quickly, place all your fingers on the iPad, then move from right to left. This gesture enables you to switch quickly between your current app and last used app without bringing up the multitasking bar. You don't get a selection of apps to choose from, so it's most useful when frequently moving between two apps.

10 THREE-FINGER DOUBLE-TAP

To enable these next three gestures, you must activate them by going into the Settings app, tapping on Accessibility and then choosing Zoom. Once enabled, if you double-tap the screen with three fingers you will zoom into the screen, similar to the Spread gesture. However, this gesture can be done anywhere — including the Home screen.

11 THREE-FINGER SCROLL

When you're zoomed in with a three-finger double-tap, you can navigate around the screen by tapping and holding three fingers on the iPad and scrolling with them. This enables you to navigate around a zoomed app (or the Home screen) while still letting you use normal gestures (such as Tap and Swipe) to operate the app.

12 THREE-FINGER DRAG

The regular three-finger double-tap zoom is binary: it's either zoomed or it's not. To change the level of zoom, double-tap the iPad with three fingers again, but hold your fingers down after the second tap. Now scroll up or down to change the level of zoom. No matter how far you zoom in, a three-finger double-tap will bring you back to where you were.

Get to grips with Docker and app containers

It took a lot of convincing for a lethargic Mayank Sharma to power down his virtual machines and learn to virtualise apps instead.

Even if you're totally disconnected with the realm of mortal beings, you'd still surely have heard of Docker and how it can solve all your IT problems. If you have somehow managed to isolate yourself from experiencing the fruits of Docker's goodness, here's your chance to absolve yourself.

Traditional virtualisation technologies provide full hardware virtualisation. This is to say that the virtual machine or hypervisor takes chunks of physical resources such as CPU, storage and RAM, and then slices them into virtual versions like virtual CPUs and virtual RAM. It then uses these virtual peripherals to build virtual machines that behave like regular physical computers.

The isolated virtual environment is useful for testing a new distro, but is an overkill when all you need to virtualise is a single program.

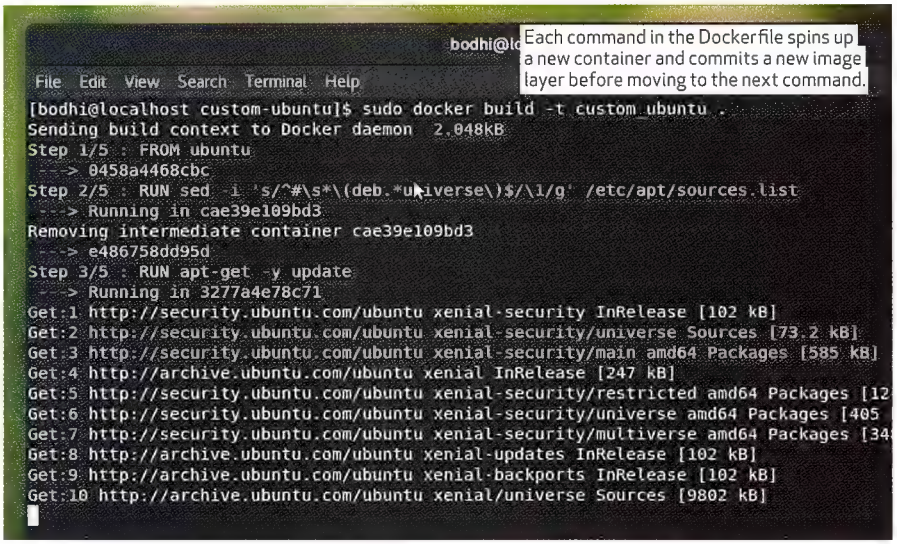
This is where Linux containers – through Docker – offer an attractive alternative. Docker enables you to bundle any Linux app with all its dependencies and its own environment. You can then run multiple instances of the containerised app, each as a completely isolated and separated process, with near native runtime performance. That's because, unlike VMs, containers share the same host system kernel. This also means that you can host more containers than VMs on any given hardware, because of its lighter footprint.

THE LANGUAGE OF DOCKER

Docker is a container runtime engine that makes it easy to package applications and push them to a remote repository, from where other users can download and use them.

Let's get familiar with some Docker terminology. Docker containers package software in a complete filesystem that includes everything an application needs to run. This ensures the app will always run the same way – irrespective of the environment Docker is running on.

A Docker image is the definition of a container. It's a collection of all the required executables, files, environment settings and more, that make up an application along with its dependencies. The image is a read-only version of your application that's often compared to an ISO file. To run this image, Docker creates a container out of it by cloning the image. This is what then actually executes. This arrangement makes Docker very scalable and enables you to run multiple containers from the same image.


bodhi@lc
File Edit View Search Terminal Help
[bodhi@localhost custom-ubuntu]$ sudo docker build -t custom_ubuntu .
Sending build context to Docker daemon 2.048kB
Step 1/5 : FROM ubuntu
---> 0458a4468cbc
Step 2/5 : RUN sed -i 's/^#\s*\(deb.*universe\)$/\1/g' /etc/apt/sources.list
---> Running in cae39e109bd3
Removing intermediate container cae39e109bd3
---> e486758dd95d
Step 3/5 : RUN apt-get -y update
---> Running in 3277a4e78c71
Get:1 http://security.ubuntu.com/ubuntu xenial-security InRelease [102 kB]
Get:2 http://security.ubuntu.com/ubuntu xenial-security/universe Sources [73.2 kB]
Get:3 http://security.ubuntu.com/ubuntu xenial-security/main amd64 Packages [585 kB]
Get:4 http://archive.ubuntu.com/ubuntu xenial InRelease [247 kB]
Get:5 http://security.ubuntu.com/ubuntu xenial-security/restricted amd64 Packages [12
Get:6 http://security.ubuntu.com/ubuntu xenial-security/universe amd64 Packages [405
Get:7 http://security.ubuntu.com/ubuntu xenial-security/multiverse amd64 Packages [34
Get:8 http://archive.ubuntu.com/ubuntu xenial-updates InRelease [102 kB]
Get:9 http://archive.ubuntu.com/ubuntu xenial-backports InRelease [102 kB]
Get:10 http://archive.ubuntu.com/ubuntu xenial/universe Sources [9802 kB]
Each command in the Dockerfile spins up a new container and commits a new image layer before moving to the next command.

While Docker is available as a package in the official repositories of all popular distributions, it's best to fetch the latest version from the official Docker repository. Fire up a terminal and fetch the official download script and execute it with `curl -sSL https://get.docker.com/ | sh` to install Docker. Once it's installed, start the Docker service with `sudo systemctl start docker` and make sure it starts on subsequent boots with `sudo systemctl enable docker` .

Now type `docker run hello-world` to test the installation. The command downloads a special image from the official Docker registry that will greet you if all goes well and explain the steps it took to test your Docker installation.

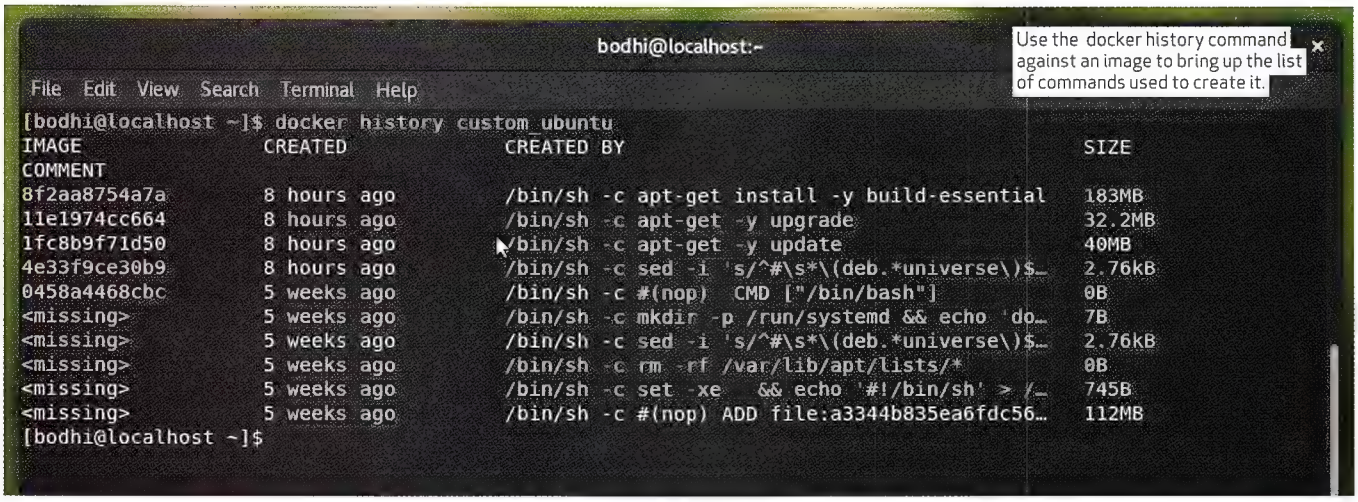
Now's let's jump straight in and start a new Docker container with the following command:

```
$ docker run -it --name
alpha-silo ubuntu /bin/bash
```

With this command, we asked Docker to start a new container with an image called Ubuntu. The `-i` makes the session interactive and the `-t` allocates a terminal. The container is named alpha-silo and runs the /bin/bash command once it's started.

When we issue the command, the Docker daemon will search for Ubuntu images in the local cache. When it doesn't find one it then downloads the image from Docker Hub. It'll take some time to download and extract all the layers of the images. Docker maintains container images in the form of multiple layers. The good thing about this arrangement is that these layers can be shared across multiple container images. This makes the system very efficient. For example, if you have Ubuntu running on a server and you need to download the Apache container based on Ubuntu, Docker will only download the additional layer for Apache as it already has Ubuntu in the local cache, which can be reused.

Once this container has been started, it will drop you in a new shell running inside it. From here, you can interact with the shell just as you would on a normal installation. However, because containers are designed to be extremely lightweight,


bodhi@localhost:~
File Edit View Search Terminal Help
[bodhi@localhost ~]$ docker history custom_ubuntu
IMAGE CREATED CREATED BY SIZE
COMMENT
8f2aa8754a7a 8 hours ago /bin/sh -c apt-get install -y build-essential 183MB
11e1974cc664 8 hours ago /bin/sh -c apt-get -y upgrade 32.2MB
1fc8b9f71d50 8 hours ago /bin/sh -c apt-get -y update 40MB
4e33f9ce30b9 8 hours ago /bin/sh -c sed -i 's/^#\s*\(deb.*universe\)$… 2.76kB
0458a4468cbc 5 weeks ago /bin/sh -c #(nop) CMD ["/bin/bash"] 0B
<missing> 5 weeks ago /bin/sh -c mkdir -p /run/systemd && echo 'do… 7B
<missing> 5 weeks ago /bin/sh -c sed -i 's/^#\s*\(deb.*universe\)$… 2.76kB
<missing> 5 weeks ago /bin/sh -c rm -rf /var/lib/apt/lists/* 0B
<missing> 5 weeks ago /bin/sh -c set -xe && echo '#!/bin/sh' > /… 745B
<missing> 5 weeks ago /bin/sh -c #(nop) ADD file:a3344b835ea6fdc56… 112MB
[bodhi@localhost ~]$
Use the docker history command against an image to bring up the list of commands used to create it.

you only have access to a barebones environment.

When you are done, you can exit from the shell by typing exit or pressing 'Ctrl-D'. Outside the container, you can use the `docker ps` command to list all the containers and check the status of your last container. By default, the command only lists running containers. Append the `-a` option to the command to list stopped containers as well. To start the container again, you can use the docker start command, such as `docker start -ia alpha-silo` .

The `-i` option will, as before, start the container in interactive mode and the -a option will attach to a terminal inside the container. If you start a container without any option, such as `docker start alpha-silo` , Docker will launch it in the detached mode, which is to say that it wouldn't latch the container onto the terminal and just keep it running in the background.

You can open a terminal inside a detached container with docker attach, like `docker attach alpha-silo` . To detach the terminal but keep the container running in the background, press the 'Ctrl-P-Q' key combination. To execute a command inside a running container, use docker exec, such as `docker exec alpha-silo pwd` to print the current working directory inside the container.

Remember we said containers are designed to be lightweight? If you list all the processes running inside our Ubuntu container with the `docker alpha-silo exec ps -elf` command, you'll notice that it's running bash and nothing else. That's why when we exit from the shell by typing exit, the action stops the container as well since it is the only process running in the container.

The `docker stop alpha-silo` command will gracefully stop the container after stopping processes running inside it. When you no longer need the container, you can use docker rm to remove/delete it, such as `docker rm alpha-silo` . The table (over the page) lists some frequently used Docker commands and their uses.

FLESH OUT THE CONTAINER

We've just created a minimal container named alpha-silo using the base Ubuntu image that doesn't do much. To get more out of this container, you can either download another image that uses the same base image, but has more stuff baked in. You can also manually add software to the base image, just as you would on a regular install. Start an interactive shell inside the container and type:

```
$ sudo apt update; apt install net-tools apache2 -y
```

This command will update the repositories and install the net-tools and the Apache web server inside the container. One of the cool things about Docker is that it enables you to save your customised container as a custom image that you can then use to spin additional containers. So if we exit the container and type:

```
$ docker commit -a "Mayank Sharma" alpha-silo loaded-silo
```

...Docker will roll the customised container alpha-silo with the updated repos and the Apache web server into a custom image called loaded-silo. In the command, the `-a` option is the name of the author of the image. Then comes the name of the container being imaged (alpha-silo) followed by the name of the new image (loader-silo). The new loaded-silo image is now stored as a separate image on the server along with the others as you can verify with the `docker images` command. You can now use this image to spin new containers.

REAL-WORLD CONTAINERS

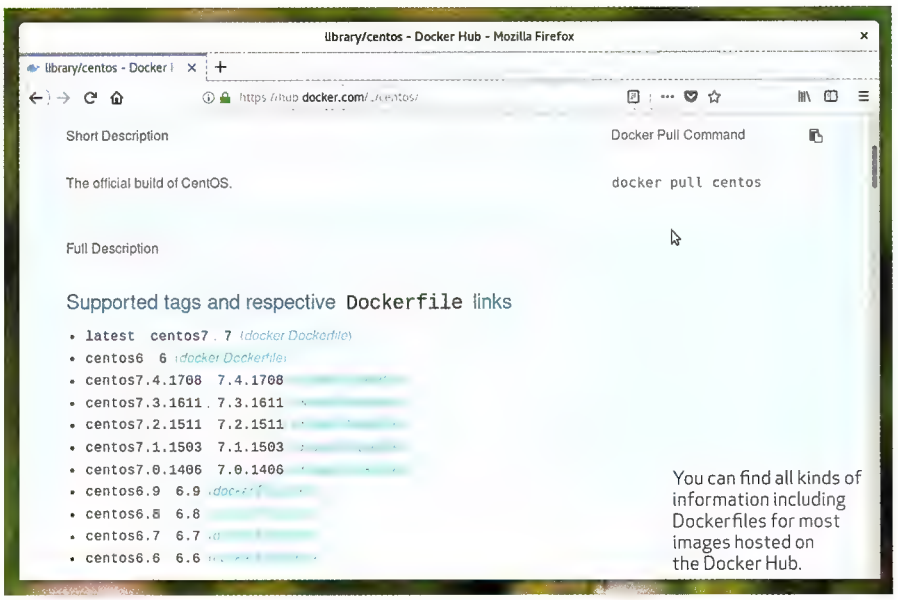
As we've said earlier, a Docker container is an instance of a Docker image. Docker pulls images from repositories that live inside registries.

Distros optimised for Docker

A Docker container includes both the application along with all its configuration and dependencies. So you can streamline a distro to host containers only. The community has latched on to this, which is why you have several stripped-down container-oriented distros such as Container Linux, RancherOS and Atomic Host. While you can run a container on top of a regular distro, these fine-tuned distros have become the norm for running containers in a production environment.

Each of these distros comes with its own set of features that make them suitable for different kinds of deployments. Container Linux (formerly known as CoreOS), is a production-ready operating system that's built from scratch for hosting containers. One of its advantages is that it automatically detects a new Docker container as soon as it comes online in the network. The distro also uses Google's Kubernetes to manage the Containers. Then there's RancherOS that is interesting because it is essentially made up of Docker Containers. It boots up with a container called System Docker, and then gives users the ability to create new containers with User Docker.

If you run Red Hat-compatible servers with either CentOS, Fedora or RHEL, there's the Atomic Host project that creates tailored builds for these Red Hat servers for integrating Docker into your network. There's also Alpine Linux, which started out as a fork of the LEAF (Linux Embedded Appliance Framework) project. Its creator now works for Docker, which uses the distro to build its packages.


library/centos - Docker Hub - Mozilla Firefox
Short Description
The official build of CentOS.
Docker Pull Command
docker pull centos
Full Description
Supported tags and respective Dockerfile links
You can find all kinds of information including Dockerfiles for most images hosted on the Docker Hub.

The default Docker repository is Docker Hub, which has a bunch of official and user-contributed unofficial repositories, each of which in turn contains a number of images.

So head over to **hub.Docker.com** to browse through a library of pre-built Docker images. To get familiar with Docker, we'll use it to install the WordPress blogging app. The WordPress image on Docker Hub doesn't include a database installation. So we'll first have to install a MariaDB database in a separate container and then ask the WordPress container to use it.

Start off by making a new directory where you wish to store the files for WordPress and MariaDB for example in your home directory:

```
$ mkdir ~/wordpress
$ cd ~/wordpress
```

Then pull the latest MariaDB image with:

```
$ docker run
  -e MYSQL_ROOT_
PASSWORD=<password>
  -e MYSQL_DATABASE=wordpress
_db
  --name db4wp
  -v $(pwd)/database:/var/lib/
mysql
  -d mariadb
```

The `-e` option sets the environment variables for the container, such as the database password and its name. Replace <password> above with your own. The `--name` option defines the name of the container. The most interesting option is `-v "$(pwd)/database":/var/lib/mysql`. It asks Docker to map the two specified locations that are separated by the colon (:). On the right is the /var/lib/mysql directory that exists within the container and is used to store the database file. The command asks Docker to place the files under the /database folder in the current working directory on the host to ensure that the data persists even after we restart the container. The `-d` option tells Docker to run the container in the detached daemon mode in the background.

This command will download the latest version of the official MariaDB image and put it inside a container with the specified settings. You can confirm that the MariaDB container is running with `docker ps`.

You can also break the process into two steps, which is what we'll do for WordPress. First we'll just download the WordPress image with `docker pull wordpress` and then build a container for it, with:

```
$ docker run -e WORDPRESS_
DB_PASSWORD=<password>
  -d --name my_wordpress
  --link db4wp:mysql
  -v $(pwd)/html:/var/www/html
  -p <server public IP>:80:80
wordpress
```

Make sure you set the `-e WORDPRESS_DB_PASSWORD` variable to the same password as that of the MariaDB database. The `--link db4wp:mysql` option links the WordPress container with the MariaDB container so that the applications can talk to each other. The `-v` option does the same function as it did for the database and makes sure that the container's contents under the /var/www/html directory are persistently stored in the /html folder under the current directory on the host.

The `-p <server public IP>:80:80` tells Docker to pass connections from the servers' HTTP port to the containers' internal port 80. Replace <server public IP> with the public IP address of your server. Instead of a public IP address, you can also use `-p 127.0.0.1:8080:80`, to tell Docker to forward the container's port 80 to port 8080 on the local host. To access the WordPress installation, open a browser on a computer in the same network as the server running the Docker daemon and head to **http://<IP ADDRESS OF Docker SERVER>:8080**.

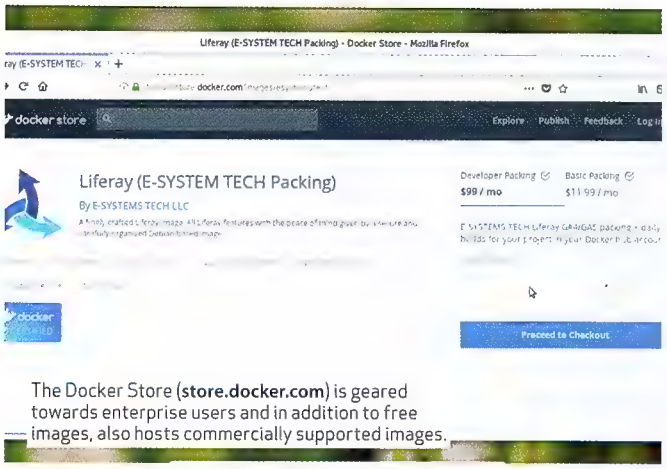
Use `docker inspect wordpress` to get all the settings for the WordPress container. To check the log file for our WordPress container, run the `docker logs -f wordpress` command. You can stop a container with `docker stop`, start it again with `docker start` or restart it with `docker restart`. But if you have to change a parameter, like the port mapping, you'll first have to stop a container, then remove it and then start another one with the new parameters with the `docker run` command.

DOCKER COMPOSE

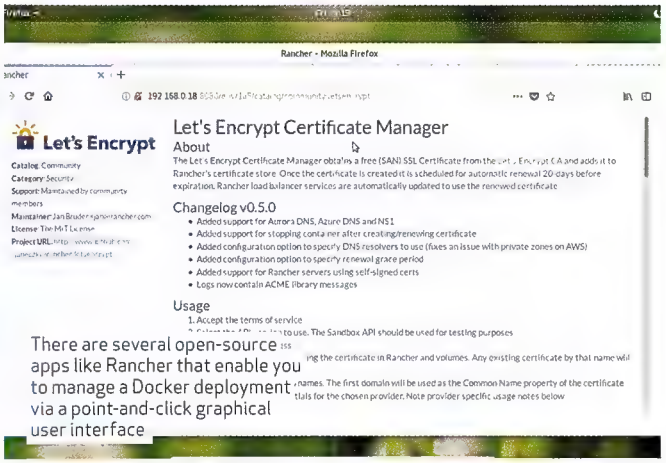
While the Docker CLI is very well documented, it isn't the most intuitive mechanism for creating containers. This is why you need to use the docker-compose tool to define and run containers. The tool makes it particularly easy to roll multiple containers. It's essentially made up of a human-readable YAML data

common Docker commands

COMMAND	WHAT IT DOES
docker info	Displays details about the Docker daemon
docker ps	Lists all running containers
docker inspect	Displays the configuration of a container
docker logs	Displays the standard output from a container
docker exec	Executes a command in a running container
docker images	Displays local images
docker run	Initiates a new container
docker pull/push	Downloads/uploads images from/to a remote registry
docker start/stop	Starts or stops a container
docker rm	Removes a container
docker rmi	Removes an image



The Docker Store (**store.docker.com**) is geared towards enterprise users and in addition to free images, also hosts commercially supported images.



There are several open-source apps like Rancher that enable you to manage a Docker deployment via a point-and-click graphical user interface

serialisation language that lists the characteristics or options of one or more containers that can then be brought to life with a single command.

To demonstrate its advantages over the Docker CLI, we'll recreate our MariaDB and WordPress containers with Docker Compose. First install the latest version by pasting a cURL command mentioned in the Docker Compose documentation (**docs.docker.com/compose/install/#install-compose**). When you've got Compose up and running, change into the ~/wordpress folder and create the docker-compose.yaml file:

```
$ cd wordpress
$ vi docker-compose.yaml

dbase4wp:
  image: mariadb
  environment:
    MYSQL_ROOT_PASSWORD:
<password>
    MYSQL_DATABASE:
wordpress_db
  volumes:
   - ./database:/var/lib/mysql

my-wp:
  image: wordpress
  volumes:
    - ./html:/var/www/html
  ports:
    - "8080:80"
  links:
    - db4wp:mysql
  environment:
    WORDPRESS_DB_PASSWORD:
<password>
```

The options are the same as before, only more verbose. Save the file and then type `docker-compose up -d` to create both the containers. Use `docker-compose logs -f` to monitor the output of the containers.

CREATE A DOCKER IMAGE

As we know every Docker container is an instance of a Docker image. Sure, there's a huge repository of pre-built Docker images available in Docker Hub and elsewhere. But just as we manually fleshed out the Ubuntu image earlier, we can automate the process and ask Docker to build us a custom image using a base image.

To build a Docker image we need to create a Dockerfile, which is a plain text file with instructions and arguments to assemble an image. Refer to the table (below) for a list of commands that go inside a Dockerfile. You don't have to use every command. In fact, here's a fully functional Dockerfile:

```
$ vi Dockerfile
## specify the base image
FROM ubuntu:artful
## enable the Universe
repository
RUN sed -i 's/^#\s*\
(deb.*universe\)$/\1/g' /etc/
apt/sources.list

## update the repositories
RUN apt-get -y update

## install any available
upgrades
RUN apt-get -y upgrade

## install the build-
essential metapackage
RUN apt-get install -y build-
essential
```

Remember, however, that while you can place the Dockerfile anywhere you want, when you build an image from it any files and directories in the same location or further down the filesystem in the sub-directories gets included in the build. It's a good idea to create a directory especially for placing the Dockerfile. Once a Dockerfile is written, you can use it to create an image:

```
$ docker build -t custom_
ubuntu
```

This command will build an image in the current directory called custom_ubuntu based on the instructions in the Dockerfile. When it's done, you can confirm the image is available along with the other images using the `docker images` command. You can now use this custom image to build containers.

There's a lot more you can do with Dockerbuild. In fact, we've barely scratched the surface, but you should now be equipped with the tools and the know-how to experience the goodness and convenience of Docker containers.

Dockerfile commands

COMMAND	WHAT IT DOES
FROM	Specify the base image
RUN	Used to execute a command during the build process
CMD	Executes a command within the container
WORKDIR	Sets the path where the command, defined with CMD, is to be executed
ADD	Copy a file from the host machine to the new docker image
ENTRYPOINT	Default command that'll be executed whenever a container is created with the image
ENV	Defines environment variables
EXPOSE	Exposes a specific port between the container and the outside world
USER	Sets the user or UID for the container created with the image
VOLUME	Enable the container to access a directory on the host machine
MAINTAINER	The name of the image maintainer

The zenith of high-end builds?

AMD's 12nm manufacturing process makes its debut in Zak Storey's latest build.

THE CONCEPT

It's good to have some competition back in the industry once again. Seriously, how long were we plodding on with mainstream quad-core processors? Over eight years? Staggering. The reality is that the computing industry thrives on competition, and as years pass, and more and more manufacturers hit the dirt, the likelihood of us ever seeing such a large paradigm shift again – certainly when it comes to processor performance – is slim at best.

AMD's Zen architecture is, without a doubt, the catalyst for the retirement of that mainstream staple quad-core part. And with it, we've seen an accelerated processor arms race between the two top chip manufacturers. As Intel scrambles to try to reclaim the consumer multithreaded performance title, with six-core parts on sale now, and eight-core parts rumoured to be just around the corner, it does make you question what exactly it was that was holding Intel back all this time?

Alas, we digress – this isn't about who did what best, this is about the launch of a new processor generation: AMD's first foray into its Ryzen refresh. Its original lineup of Ryzen processors rocked the world with their multithreaded price to performance. But single-core? Well, that had problems, serious problems, and those were reflected in game, too. Now, AMD tells us, it has almost entirely remedied that situation, and with the disparity between Intel and AMD's latest parts nearing a meager 1% performance difference across a plethora of titles, is it time to jump ship to Team Red? We investigate.

SECOND-GEN JOY

So this system is a little nutty – it doesn't exactly fall into the category of an efficient gaming machine, nor does it delve into the realms of enterprise workstation. In short, we were given one mission statement for this build: craft a rig housing Zen+ that looks good. So that's exactly what we aimed for. Couple that with this particular writer's high-end balanced approach to hardware selection, and what you're left with is a top-level machine that's perfectly optimised for both throwing down in-game frame rates, and ably finishing any editing task you have to hand.

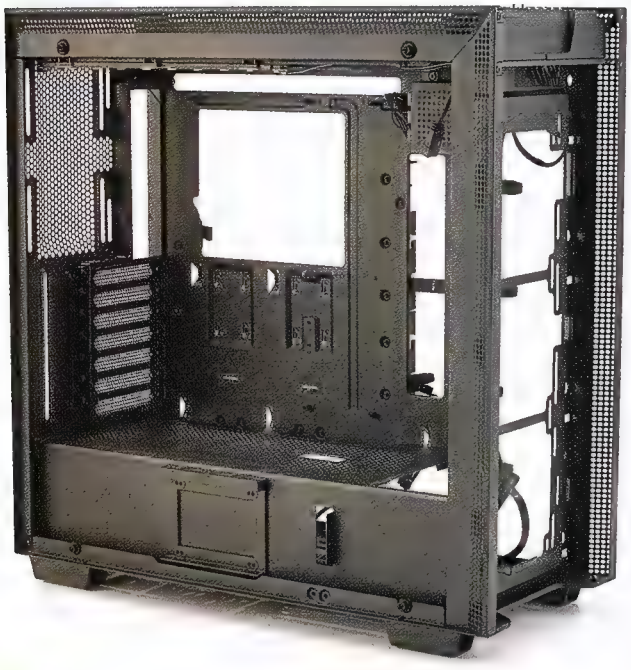
As is typical of us here at *APC*, the storage we've chosen is one of the biggest expenses in this build. That's no chump-change hard drive for the OS there, no sir. That's 480GB of the finest 3D Xpoint Intel Optane solid-state storage. On tap, ready to deliver premier-level performance for any and all editing applications out there. Unfortunately, it's not cheap. At $849 for the exotic plug-in PCIe storage stick, it's almost at the $2 per GB mark ($1.77 to be exact). But, oh boy, does it rip up the playbook when it comes to random 4K read and writes – arguably the most important metric when it comes to SSD performance.

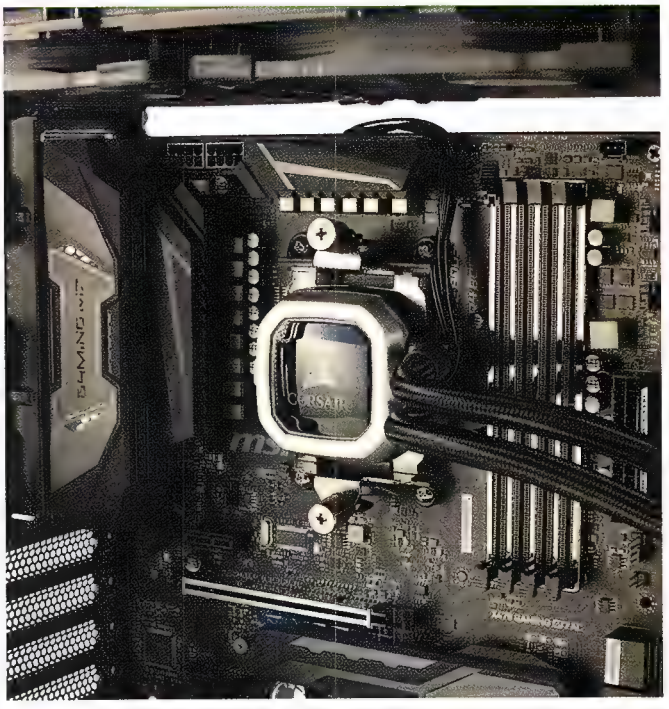
On top of that, we've thrown in a hefty 1TB Samsung 860 Evo for any additional storage needs, and some (still excessively expensive) Corsair Dominator Platinum DDR4 sticks, which clock in at a total of 32GB (4x 8GB, dual-channel), running at a fairly average 3,200MT/s clock. All of which is ideal for Ryzen's fabled infinibro fabric. With that out of the way, then, let's get on to the build.

PARTS LIST

PART		STREET PRICE
CASE	NZXT H700I	$259
MOTHER-BOARD	MSI X470 GAMING M7 AC	$419
CPU	AMD RYZEN 7 2700X	$469
CPU COOLER	CORSAIR HYDRO H115I PRO	$199
GPU	MSI GEFORCE GTX 1080 GAMING X 8G	$899
MEMORY	32GB (4X 8GB) CORSAIR DOMINATOR PLATINUM @ 3,200	$709
PSU	850W CORSAIR RM850X WHITE 80+ GOLD	$249
STORAGE 1	480GB INTEL OPTANE SSD 900P	$849
STORAGE 2	1TB SAMSUNG 860 EVO 2.5-INCH SSD	$389
OS	WINDOWS 10 HOME 64-BIT	$199
TOTAL		$4,640

"This isn't about who did what best, this is about the launch of a new processor generation."





1 H700I LAID BARE

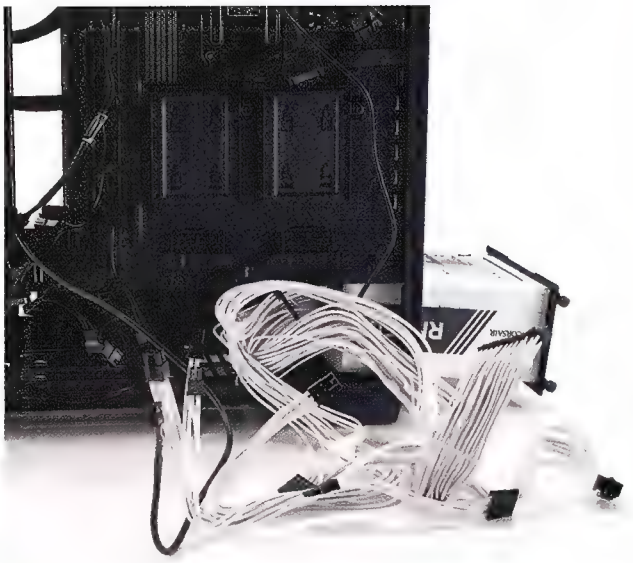
NZXT's H700i has long been a favourite in the office, mostly because of the premium interior this thing has. Interior? Yup, building in it is a dream; it's as versatile inside as it is pretty on the outside, with most of the panels easily removable. One thing that is a bit of a disappointment with this chassis is the front SSD mount. If that was just a solid panel, and you mounted the SSDs on the PSU cover, it would have made the build look far cleaner. You could even incorporate some of that super-secret-sauce LED lighting into the NZXT logo, as we saw with the Manta.

2 COOLER MOUNTING

Although Corsair's CPU block may be rather divisive aesthetically, there's no denying how beautifully easy it is to install it on the chip. Simply replace the stock Intel bracket locking mechanism on the bottom by rotating it to the right, then attach the thumb screws and locking brackets, and mount directly on to the stock AMD motherboard brackets. Simple. It's arguably one of the more secure fitting solutions we've seen on the market to date.

3 RADIATOR BRACKETS

Another neat thing baked into the H700i is this snazzy radiator bracket, situated in the top of the case. Secured down by four thumb screws, you can lift it directly out of the chassis, and pre-install your rad and fans outside of the case. Then all you need to do is slot it back into place, carefully thread your tubing and fan cables through, and you're good to go. It's worth noting that we did have a bit of a conflict here with our 140mm fans and the stock LED strip NZXT has baked into the top of the chassis, forcing us to remove the strip.



4 EASY CABLES

Modular power supplies are great, up to the point where they're installed in the case. It's a small tip, but the best thing to do is pre-attach all the cables to the PSU outside of the case first, then thread them through the PSU slot, before securing the power supply in place. The H700i comes with a PSU bracket that you pre-mount to the PSU, then slide it into place, and secure it down first.

5 LED FAILS, SORTA...

Trying to figure out how exactly to light this case was a challenge. As always, the best kind of lighting is that which is hidden. Keep the emitters out of sight, and just throw the light where you want it to go. We tried throwing it in the bottom first, but that conflicted with the cable hide bar's mounting points, and was also blocked by the SSD. We tried throwing it up top, but it was in view. So the only other option was up at the front of the case. It's visible with the side panel off, but otherwise it's kept out of sight fairly well. If we'd have gone with a 240mm AIO in the roof, we might have been able to hide another strip up there, which would have been ideal, if we're honest. However, with the 280mm, it was just too tight up there.

6 INTEL OPTANE POWAH!

Ahh, the beauty of a joint AMD-Intel partnership. Going with the $849 Optane PCIe SSD was a last-minute decision. In short, it was a toss-up between this and a Samsung 960 Pro, but in the end, we simply couldn't resist the Optane's random read and writes. There's also something strangely satisfying about having a PCIe add-in card SSD in a rig, especially when you're running a single-card build like this.

1 These streaky cables have been driving us insane. Corsair does include some cable combs with the PSU, but they simply don't fit — at least, our sample's didn't.

2 By default, MSI's X470 Gaming M7 AC supports dual eight-pin EPS power to better balance CPU juice. However, you can run with a single eight-pin just fine.

3 Front airflow is powered by a set of stealthily installed Noctua NF-A14 PWM Chromax fans.

4 Not that you can see them from this angle, but removing the 3.5-inch hard drive cage below the PSU cover helped give us a bit more wiggle room in the rear for all the cables we needed.

Ryzen shine

A smattering of lighting, a few braided cables, sexy silver heat pipes, and some sleek tempered glass was all it took to raise this build to the heady heights of a premium PC. The hardware within is powerful, and more than capable of producing the results you need, both in game and out.

But was it a breeze to build? There's always some pitfall, right? Some unexpected, frustrating anomaly to deal with on these rigs. Surely, the H700i isn't exempt from Murphy's law? Actually, there wasn't much in the way of problems this time around.

Admittedly, it did take us longer than usual to put this beauty together, and that came down to two hiccoughs. First and foremost: the panels. Both the front and top fascias have the traditional plastic locking pins that secure chassis panels in place, which is fine. However, the ones in the H700i are particularly tricky to pop out. Combine their reluctance to budge with their potential fragility, and you suddenly start panicking about the possibility of snapping them off completely.

The second problem came from that radiator bracket we mentioned earlier. The first time we installed the AIO, we forgot to attach and thread through the fan cables on the Noctua AF-14s we were using. The second time, we noticed the thumb screws wouldn't secure it, because the fans themselves came into contact with the RGB LED light strip NZXT had embedded in the top. The answer in the end was to remove the LED strip entirely (simply two Phillips head screws), then unplug it from NZXT's integrated CAM fan controller.

As for performance? Well, we'll leave the majority of the metrics to speak for themselves, so far as computational performance goes.

One thing we haven't really spoken about is the graphics. We decided to go with an MSI GTX 1080 8G for this rig. You can pick one of these up right now for around $900 (hopefully less by the time you're reading this), and it's fast becoming our 1440p GPU of choice.

Is there anything we'd change? That depends on the circumstances. Other than adding better cable combs, the only thing that really stands out is the storage configuration. If this were solely a gaming machine, a 500GB SSD up front and a 2TB hard drive in the back would have made much more sense, and save us a fair bit ditching the Intel drive, too. Otherwise, it's a pretty slick setup for a high-end enthusiast. ■

BENCHMARK RESULTS

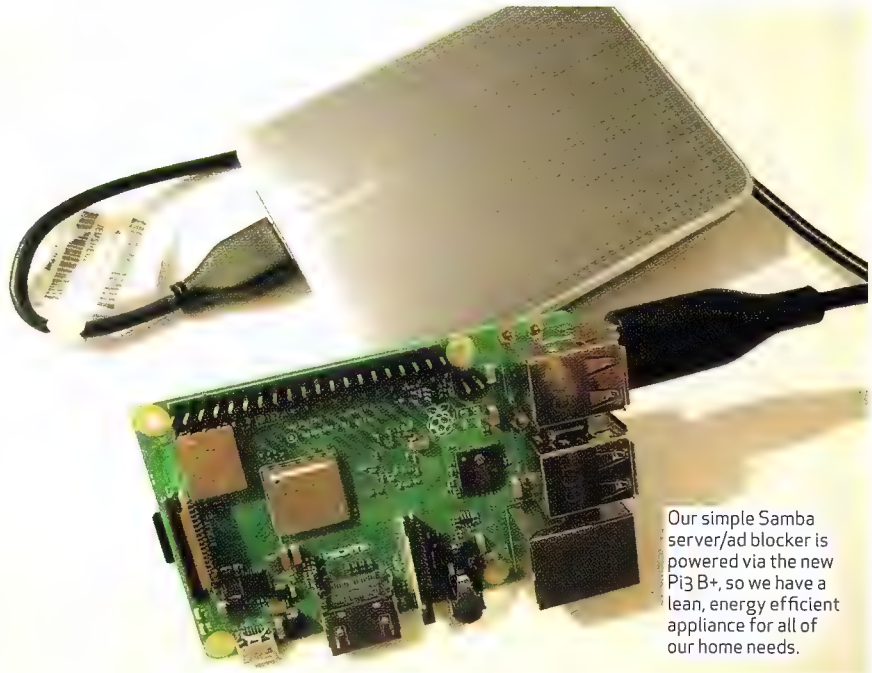
	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	2,178	1,832 (-16%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,136	2,715 (-13%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	2,126	2,283 (7%)
RISE OF THE TOMB RAIDER (AVG FPS)	68	48 (-29%)
TOTAL WAR: WARHAMMER II (AVG FPS)	42	31 (-26%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	38	30 (-21%)
3DMARK: FIRE STRIKE (INDEX)	6,988	5,456 (-22%)

Our *APC* Labs test PC consists of an Intel Core i9-7900X, 32GB G.Skill Ripjaws V Series DDR4 @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512GB Samsung 960 Pro PCIe SSD. All tests performed at 4K at the highest graphical profile.

Create a cheap, Pi-powered ad-blocker and file server

Les Pounder shows how to use the power of the new Raspberry Pi 3 B+ to create a file server and ad blocker in one compact device!

To celebrate the release of the new Raspberry Pi 3 B+, we'll use it to create our own Samba server to store files and media for access across our home network. We'll then use the same Pi to block ads and create a better browsing experience.



Our simple Samba server/ad blocker is powered via the new Pi3 B+, so we have a lean, energy efficient appliance for all of our home needs.

SAMBA FILE SERVER

First things first: Let's make sure that we have the latest version of Raspbian. Download this from the Raspberry Pi website (**www.raspberrypi.org**) and then, using your favourite tool, flash the image to a blank micro SD card. When completed, eject the card and place it into your Pi, then connect your keyboard, mouse, screen, Ethernet and finally the power. Your Pi will boot up and, as this is the first boot, it'll expand the filesystem to fully utilise the space on your SD card.

Soon, you'll see the Raspbian desktop, so let's update our Pi. Open a terminal; the icon is in the top left of the screen. In the terminal, type the following, line by line, and press Enter at the end of each line:

```
$ sudo apt update
$ sudo apt upgrade -y
```

To ensure that we can always find the Pi on the network, let's fix the IP address of our Pi. Right-click the networking icon and select 'Wireless and Wired Network Settings'. In the Network Preferences dialog, configure interface eth0. Tick 'Automatically configure empty options' and then change the IPv4 Address to match that of your network. For example, our network uses 192.168.0.xxx so we chose to fix the IP address to 192.168.0.100. Click Apply and then Close. Now reboot the Pi to ensure that the IP address has been changed, and to check we can open a terminal and type.

```
$ hostname -I
```

With the terminal still open, let's install the Samba package. Type the following and press Enter.

```
$ sudo apt install samba samba-common-bin
```

With everything installed, we now need to insert our USB storage device, which we shall use as our shared storage. Raspbian will automatically mount the drive for us, but we need to know where it's mounted. In the terminal, enter the following command:

```
$ mount | grep /dev/sd
```

Now, if there's only one USB stick inserted we should see a device labelled /dev/sda1. This is our USB stick, so make a note of the device and where it's mounted, typically in /media/pi/. Make a note of the full path to the drive. So we now have the device that's our USB drive, and it has a directory that we wish to share using Samba. Let's tell Samba where to find the drive. In the Terminal, type the following to edit the smb.conf file.

```
$ sudo nano /etc/samba/smb.conf
```

When the file loads, go to the bottom of the file and recreate the following lines:

```
[share]
Comment = Pi shared folder
Path =  /media/pi/<NAME OF DRIVE>
Browseable = yes
Writeable = Yes
only guest = no
create mask = 0777
directory mask = 0777
Public = yes
Guest ok = yes
```

To save and exit the editor press 'Ctrl-O', then Enter, then 'Ctrl-X'. Now let's ensure that the default user, pi, is added as a Samba user. In the Terminal, type the following:

```
$ sudo smbpasswd -a pi
```

Next, to ensure that our Samba config is correct and ready to use, we need to tell Samba to restart, so in the Terminal, type:

```
$ sudo /etc/init.d/samba restart
```

With the installation complete, we now move to our Windows or Linux computer to test that we can find and use the Samba server.

On Ubuntu, we can use the file manager (*Nautilus*) to connect via the Network shortcut. The name of our server RASPBERRYPI should be visible. Click 'share' and when prompted enter the username "pi" and the password "raspberry" to access the server. The same process is similar for Windows 10 devices because the Network shortcut is also found in the File Manager application.

Android users can also download Samba client apps from the app store and access the files just like their desktop counterparts.

So now we have a single point where we can save our files and share them across the network – handy for large amount of media consumed by busy households!

SETTING UP PI-HOLE

We all dislike adverts on web pages, but installing an ad blocker on every device is time-consuming. What if we created one device that filtered all of this for us? Pi-Hole is just that device. Running on our Raspberry Pi, Pi-Hole replaces our standard DNS server (normally our ISP unless we change it) with its own that filters out the ads. Oh, and it's very easy to install, so let's get started.

We need to open a Terminal and type the following command to download and run the install script:

```
$ curl -sSL https://install.
pi-hole.net | bash
```

Note that installation via this method carries a risk if being used with unknown sources. If in doubt, download the source code and examine it before use.

Pi-Hole installation is an automated process, and requires a minimum amount of input. But there'll be times where we're asked questions. One of these questions asks us to set up a static IP address – this is unnecessary because we already have a static IP created for the Samba server (if you haven't set up a Samba server, then you can set the static IP address using Pi Hole, but make a note of the IP address.)

We'll also be asked who our upstream DNS provider is. We can choose from a list: Google or OpenDNS are popular choices. Follow the rest of the installation steps and, when asked to install the web admin, select On. After a few minutes, installation will be complete and we'll need to power down our Pi, remove all of the connections except for the Ethernet and power lead.

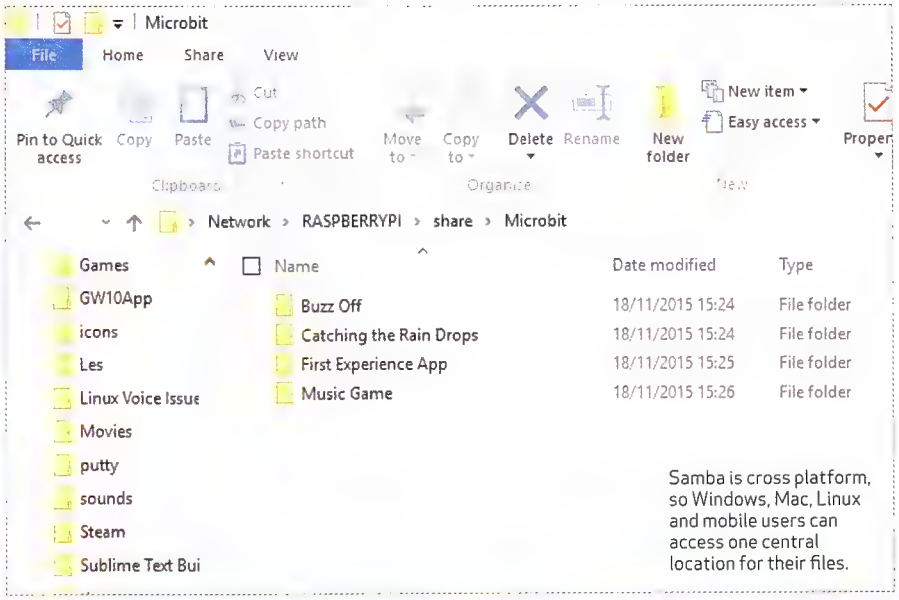
Power up the Pi and wait for it to boot – it takes around 30 seconds. On your Linux/Windows computer, go to your network settings. On Ubuntu, we can right-click the Network icon and select Edit Connections, click the interface that you wish to edit (Ethernet or Wi-Fi) and then click the Edit button. In the IPv4 Settings, change the DNS server to match the IP address of the Raspberry Pi. Click Save, then Close and then click the Network icon and then click Disconnect for the interface you have just configured.

Finally, reconnect to force the interface to connect using the Pi-Hole DNS server.

That's it! We now have a transparent ad blocker on our network. It works across all devices, including Android where we can specify a static IP address and DNS server by a long press on the Wi-Fi AP name, select Modify Network, Advanced Options, and then entering the desired static IP and the DNS server (our Pi Hole device) address.

If you love stats, then Pi-Hole has them! If you open a browser to the IP address of the server, followed by '/admin', you can see a dashboard interface that logs all of the queries blocked for your device. If you login using the password provided during the install, then you can see even more details.

So there we have it – two services using the power of the new Raspberry Pi 3 B+ – enhanced networking to keep our browser sessions free of ads, and our files saved in a convenient location.



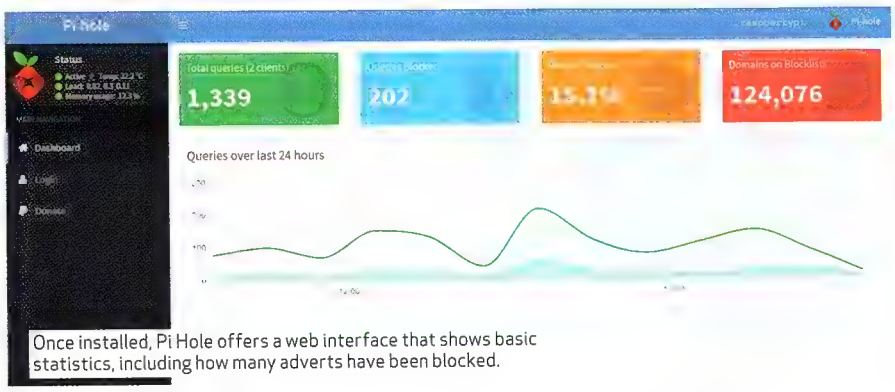
Samba is cross platform, so Windows, Mac, Linux and mobile users can access one central location for their files.

Alternative approaches

Samba is easy to set up and it works across operating systems. It can also be used to share printers over a network using the CUPS service, which is easy to install.

NFS also offers benefits for Linux users. Chief of these is that a user's Home directory can be served over the network via NFS — handy for thin client devices, while storage devices such as optical drives can be accessed as if the user is sat at that remote machine. Installing NFS is simple, and there's a guide at **help.ubuntu.com/community/SettingUpNFSHowTo** that will work with Raspbian.

If all of this file server talk has sparked an interest, then we recommend using Diet Pi (**dietpi.com**). It comes with an automatic install script for many different file servers, Pi-Hole and other servers for home automation, media cataloguing and torrents. All of which can be powered by the humble Raspberry Pi — pretty impressive, we think you'll agree.



Once installed, Pi Hole offers a web interface that shows basic statistics, including how many adverts have been blocked.

Turn your Android phone into a personal file/media server

Old Android phones don't die, they get repurposed. Darren Yates shows how to turn your leftover Android device into a personal web-based file server with free software.

Pre-paid Android phones now are just super cheap – walk into a Coles supermarket and you can often walk out with a quad-core Android phone for as little as $29. The cheapest phone I've ever purchased was a Boost Indy, a pre-paid rebadged ZTE B816 4.0-inch dual-core Android 4.4 phone for just $19. Sure, it's not an earth-shattering device and I don't make phone calls with it, but a battery-powered dual-core computer with screen, Bluetooth and Wi-Fi for $19? That's better value than a Raspberry Pi 3! Think of your phone as a computer and the instant change of mindset opens up the possibilities for pressing even cheap budget phones into many other applications. One example we're looking at this month is turning your phone into a personal file server.

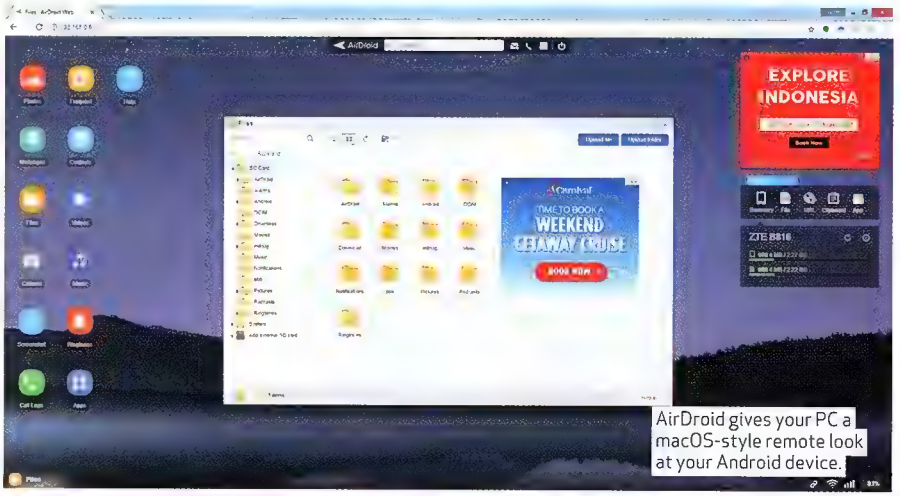
AIRDROID

There's a number of apps on the Google Play store that allow you to remotely access your phone via a separate device, whether it's another phone or a PC. We've featured the Samba Filesharing app in the past, but it has always required your device to provide root access. The fact it also uses SMB/CIFS may be enough to give security enthusiasts the jitters as well.

However, there's an alternative that doesn't require root or SMB/CIFS – and that's AirDroid (**tinyurl.com/y8tx75zw**). It allows you to access your phone – even your SMS and call logs if you wish – via any computer anywhere in the world by signing up for an AirDroid online account. However, as we'll show you, you can also just use it in 'local connection' mode, which makes it accessible to devices on your local network only via a web browser, avoiding any online sign-ups or giving AirDroid access to your call and SMS logs. We've tested it successfully on the old dual-core ZTE B816 phone we mentinoed earlier, so it should work on anything newer.

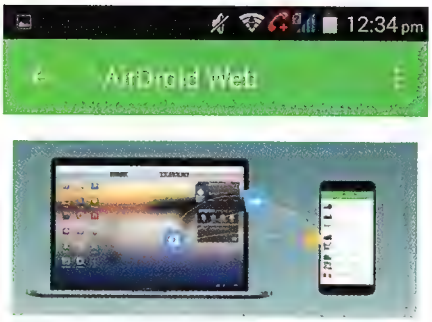
SETTING UP

Grab AirDroid from the Google Play store. During install, your Android device should indicate that AirDroid is seeking access to your SMS and call logs. Choose to 'reject' this request. Once installed, it'll take AirDroid a few seconds to launch, but then run you through a multi-screen intro. On the last screen, you'll be encouraged to 'Sign in or Sign up'. Do neither of these options – instead, click on the 'Sign in later' hotlink underneath. This switches AirDroid into 'local connection mode' – you'll only be able to access the phone using a web



AirDroid gives your PC a macOS-style remote look at your Android device.

AirDroid offers anywhere connectivity but supports local network mode.

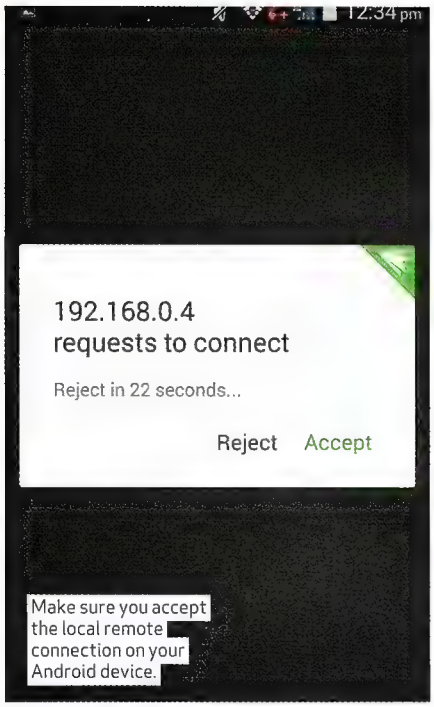


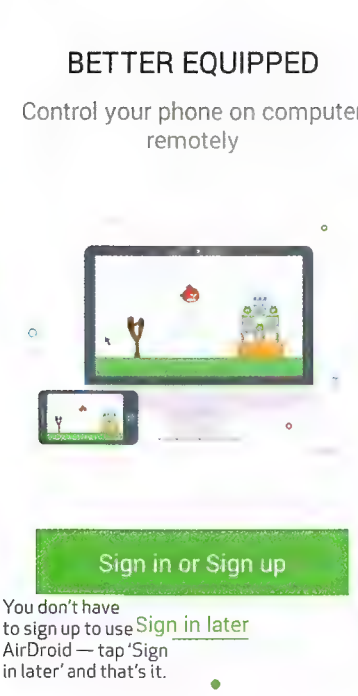
Option 1: Visit http://web.airdroid.com, sign in by an account or scanning the QR code.

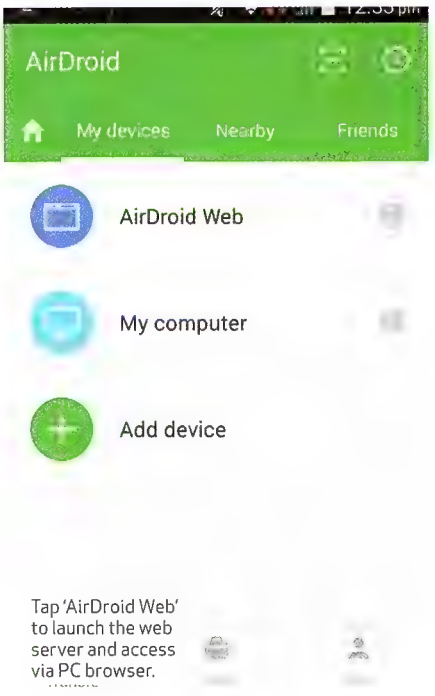
Option 2: Connect via IP address: http://192.168.0.6:8888 . The phone and computer need to be on the same local network.

Scan QR Code Learn more

Activate AirDroid Web on your phone, launch the IP address on your browser.




BETTER EQUIPPED
Control your phone on computer remotely
Sign in or Sign up
You don't have to sign up to use AirDroid — tap 'Sign in later' and that's it.
Sign in later



browser on devices connected to your local network.

Once the main AirDroid app screen appears on your Android device, you'll have three options – AirDroid Web, My computer and Add device. Tapping on 'AirDroid Web' launches the web server in the background and you'll be given two connection options for other devices. The first is via your online account (which you don't have), so ignore that one. What you do is 'Option 2' – launch a web browser on another device and type in the IP address shown in green on the AirDroid app screen. In our test case, it was the local address '192.168.0.6:8888'.

BROWSER DESKTOP

At first, your web browser will tell you to go and accept the new device connection on your AirDroid device – if you don't do it within 30 seconds, it'll be rejected automatically. There's no password protection – AirDroid seemingly figures if you're using local connection mode, you should have a fair idea of who's trying to access it, and if you don't recognise the IP address, the auto-connection-reject will fix that anyway.

However, as soon as you accept the connection on your AirDroid device, the web browser on your secondary computer is delivered a desktop interface bearing a resemblance to a macOS desktop. In fact, it's the cleanest, most well-developed web desktop environment we've seen with an app of this kind.

The ZTE B816 phone we grabbed for less than $20 has a microSD slot, able to handle cards up to 32GB and AirDroid can give you access to that storage as well. The remote AirDroid desktop displays ads, but they enable AirDroid to 'keep the lights on' and they're not too intrusive.

The built-in file manager (tap the 'Files' icon on the remote desktop) is nicely done with a standard look and feel Windows users will be familiar with. There's no having to drag-and-drop files – just double-click on them and they'll open in your web browser automatically. To download a file, click on it to highlight, then press the 'Download' button on the top-right of the Files window and the file downloads like a standard web download. Uploading files to your phone storage is similar, except you select the 'Upload File' button next door, which opens an 'Open' dialog window to select a file to upload.

GOING BEYOND

Go beyond files and AirDroid has a few extra tricks up its sleeve. For starters, it can remotely fire up your device's cameras for a live feed. Depending on the age of your AirDroid-ed phone, the video frame rate might not be anything to write home about, but for snapping off stills remotely (say, in a security situation), it's clever. You can switch from rear to front 'selfie' camera, even turn on the rear LED light if your Android device has one – all from your remote browser. You can also remotely send and receive SMSes via your Android device if needed, or even find your lost device.

AirDroid supports stream-playing MPEG-4 video files over your local network – you don't have to download first either, (although you can if you prefer), just double-click on the file and a video player window launches in your browser, with playback beginning almost immediately.

The maximum resolution of video AirDroid will successfully stream-play depends more on your Android device's CPU, your local network and the data transfer rate the two can maintain. Our test dual-core ZTE B186 phone had no trouble stream-playing a 720p (1,280 x 720-pixel) movie stored on the phone over an 802.11n network to a quad-core desktop, so that should give you at least a rough idea of what to expect.

DRAWBACK

We're calling this a 'personal' web server because the one drawback with AirDroid is that it only supports one device connection at a time in freemium mode – connect with a second device to AirDroid and the connection to the first device is closed.

Still, overall, AirDroid is a clean and capable app. If you need to access files on your phone, don't have a USB cable handy or you're ready to repurpose your old Android device and give it a new lease of life, AirDroid is a decent way to go. ■

Arduino in the real world

External devices and sensors enable Arduino to interact with the real world — and there add-ons for almost every occasion. Darren Yates explains.

Microcontroller boards, like Arduino, are awesome for the capabilities they give you as a 'maker' — you've got a mini-computer the size of postage stamp or credit card capable of running complex programming code off a few AA-sized batteries. Yet while many boards include features such as pulse-width modulation (PWM) outputs and analog-to-digital conversion (ADC), they don't typically interact with the real-world on their own. One reason is that, while computers in general operate in a world of two states (on and off or digital-one and digital-zero), the real world is analog, whether you're measuring humidity, air pressure, soil moisture, making sound or recording it.

This is where the amazing world of Arduino add-ons comes in — if you need to connect, record, measure or move something, there's usually an add-on for it. This month, we're looking at add-ons for all sorts of applications, split over five main categories — environment, audio, connection, movement and display.

ENVIRONMENT

LIGHT

A light-dependent resistor (LDR) is great for sensing changes in light. It won't give you a precise 'lux' value, but it'll detect relative changes in light easily. If you want to detect your TV remote, you'll need an infrared sensor — you'll find plenty of infrared detection modules online based on the TCRT5000 that should do the job.

TEMPERATURE, HUMIDITY AND/OR BAROMETRIC PRESSURE

Making your own weatherstation is a fun way to learn about and control your local environment, for example, starting a fan when the temperature reaches a preset level. German giant Bosch has made environmental sensors for years — the BMP180 appeared in the Samsung Galaxy S4 smartphone, measuring barometric pressure and temperature. Block sensors like the DHT11 and the higher-rated DHT22 (AM2302) are common and measure temperature and humidity. However, the best option is the Bosch BME280 — it measures temperature, relative humidity and barometric pressure in one. Get this and your weatherstation sensor tech is all but done.

SOIL MOISTURE

The YL-69 hygrometer kit lets you measure soil moisture levels, but you must connect it to the accompanying LM393 comparator module before adding it to your microcontroller. Once moisture levels drop to a certain level, it triggers — the LM393 module also allows you to adjust the sensitivity. If you want to create an automated watering system, this is where you'd start. Few eBay sellers call it by its model name, so just search for 'Arduino hygrometer'.

MAGNETIC FIELDS

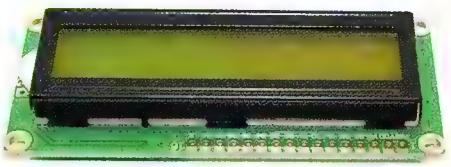
Thanks to MEMS (micro-electro-mechanical systems) technology, you can measure the earth's magnetic field with a chip. The HMC5883L is a tiny 3D or 'triple-axis' sensor and sensitive enough to use as a compass. Plus, it runs happily on 3.3VDC or 5VDC power.

TIME

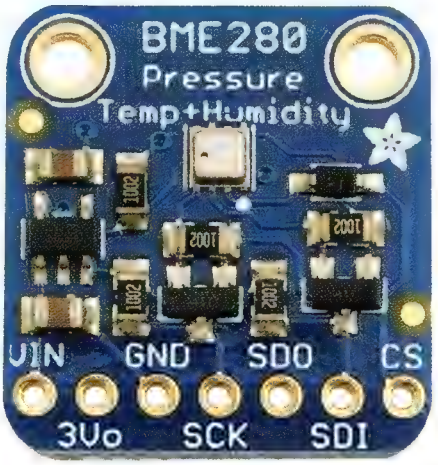
The DS1307 real-time clock module is ideal for keeping track of real time in your projects. Once you set it up, the DS1307 runs on just a CR2032 coin-battery for several years. If you need a battery-backed standalone time reference for your design, this is the easiest way to do it.

ULTRASONIC

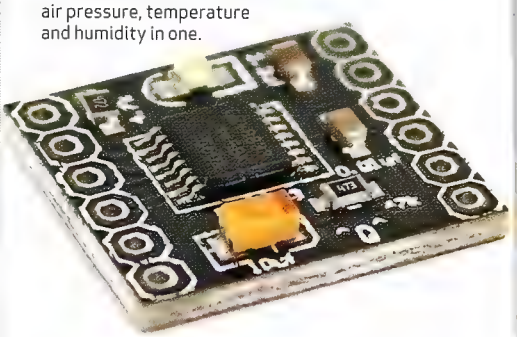
The HC-SR04 ultrasonic sensor is dirt-cheap, good for measuring distances up to three metres



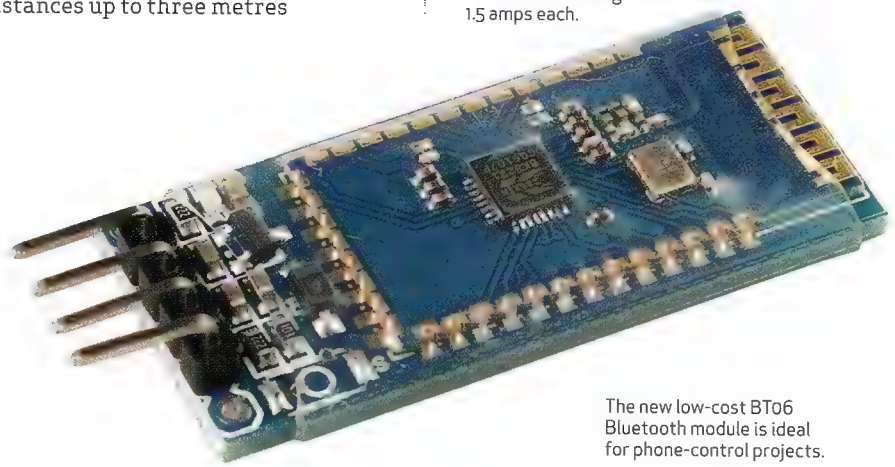
The 1602 LCD and its companion I2C module are great for DIY.



Bosch's BME280 measures air pressure, temperature and humidity in one.



The new DRV8833 motor chip drives two DC motors drawing 1.5 amps each.



The new low-cost BT06 Bluetooth module is ideal for phone-control projects.

and the perfect set of 'eyes' for your next robot. It does, however, need 5VDC to run so keep that in mind.

AUDIO

MICROPHONE

There are a few 'sound collection' sensors available, but if you want to record rather than just sense sounds, the MAX4433 module is your best bet. It features an on-board electret microphone and a preamplifier with more than 40dB (125x) gain, controllable via a tiny trimpot control on the back. It provides enough signal output for the Arduino ADC to capture meaningful levels and is happy on 3.3VDC or 5VDC power.

OUTPUT

Need to make a noise? A small 5VDC piezo buzzer can make an ear-piercing squeal connected directly to an Arduino I/O pin, but if you want to play audio, you'll need an audio amplifier. The PAM8403 is a dirt-cheap module giving you two 3-watt outputs from a single 5VDC supply. Don't expect earth-shattering quality or volume, but connect up two small 8-ohm speakers and it should be enough.

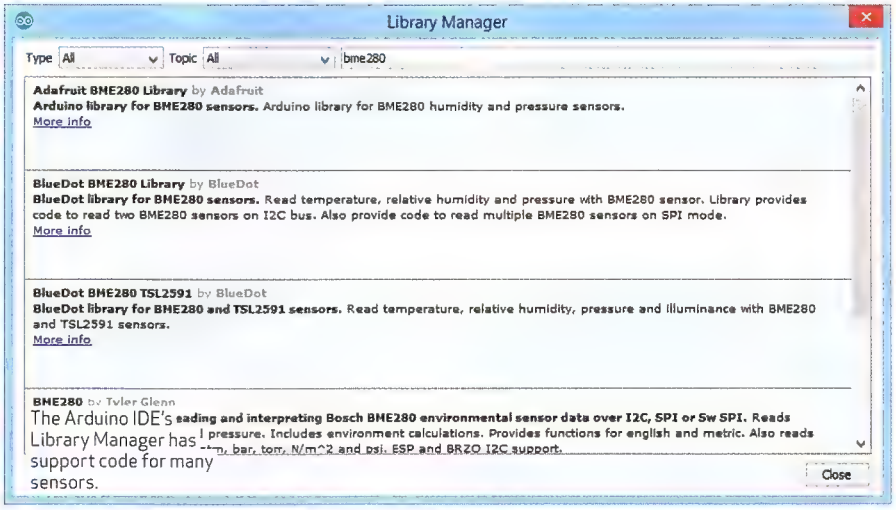
MP3 DECODING

The GPD2846A is a tiny all-in-one MP3 decoder with built-in 2-watt amplifier and microSD card reader. You control it via your Arduino. Again, it'll do the job, but don't expect stellar performance.

CONNECTION

BLUETOOTH

The HC-05 and HC-06 Bluetooth modules can add wireless connectivity to any project and also happily work on 5V power. The HC-05 can act as both 'master' and 'subordinate' whereas the HC-06 can only run in 'subordinate' mode only. The new 'BT06' is a lower-cost version of the HC-06. If you want to create gadgets you control via your phone, any of these should work nicely.


Library Manager
Type All
Topic All
bme280
Adafruit BME280 Library by Adafruit
Arduino library for BME280 sensors. Arduino library for BME280 humidity and pressure sensors.
More info
BlueDot BME280 Library by BlueDot
BlueDot library for BME280 sensors. Read temperature, relative humidity and pressure with BME280 sensor. Library provides code to read two BME280 sensors on I2C bus. Also provide code to read multiple BME280 sensors on SPI mode.
More info
BlueDot BME280 TSL2591 by BlueDot
BlueDot library for BME280 and TSL2591 sensors. Read temperature, relative humidity, pressure and illuminance with BME280 and TSL2591 sensors.
More info
BME280 by Tyler Glenn
reading and interpreting Bosch BME280 environmental sensor data over I2C, SPI or Sw SPI. Reads pressure. Includes environment calculations. Provides functions for english and metric. Also reads
Close
The Arduino IDE's Library Manager has support code for many sensors.

WI-FI

The ESP8266 revolutionised the maker Wi-Fi market and the ESP-01 module can connect to any Arduino microcontroller. There are claims the ESP8266 I/O pins are 5V-intolerant and although we've had no trouble, you should be aware. It's now superseded by the ESP32, which adds in Bluetooth Low-Energy (BLE). Both are now available as standalone micro-controllers (the ESP8266 as NodeMCU or WeMos D1 Mini), replacing the Arduino and programmable directly via the Arduino IDE.

RFID

That entry card you use to get into the office of a morning quite likely works on radio-frequency identification or RFID. You can buy RFID starter kits that include card, key fob and Arduino tap module for a few dollars and are great for experimenting with a bit of home security. Again, search 'Arduino RFID kit'.

LORAWAN

Bluetooth is good for 10 metres, Wi-Fi for around 100 metres. If you need to transmit data over kilometres, you need LoRaWAN (long-range wide-area-network). It usually requires more infrastructure than Bluetooth or Wi-Fi and if you go this route, choose 915MHz devices to match Australian frequency standards. The SX1276 is a good place to start, but know LoRaWAN is more expensive than Wi-Fi or Bluetooth.

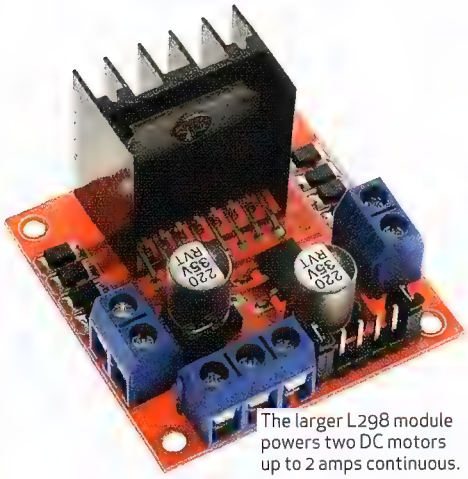
MICROSD

Need storage? MicroSD is the way to go. Just be sure to get the right module for your microcontroller. MicroSD cards run exclusively from 3.3VDC, so 5VDC Arduino boards need the taller MicroSD module with built-in voltage-level translation (sorry, these don't have model numbers unfortunately). Microcontroller boards running on 3.3VDC power can use the smaller cheaper MicroSD module that connects directly.

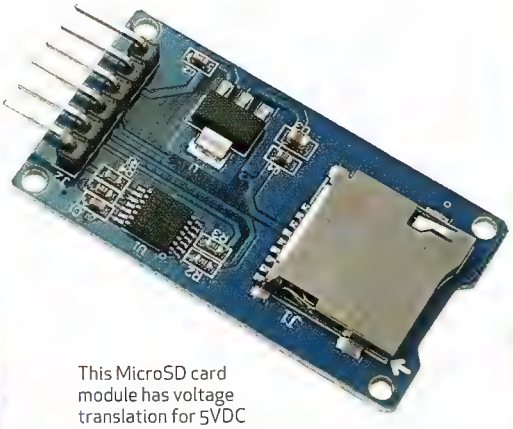
MOVEMENT

ACCELEROMETER

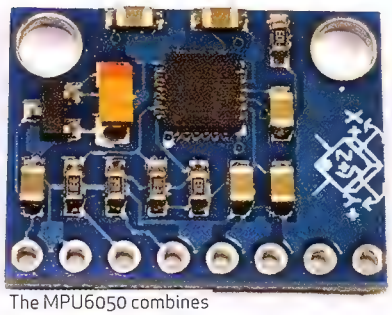
The MPU6050 chip appeared in the Nexus 7 Android tablet, but you can also buy it as a module for microcontrollers. It's a combined accelerometer and gyroscope, using MEMS tech to measure movement in three axes, including gravity.


The larger L298 module powers two DC motors up to 2 amps continuous.

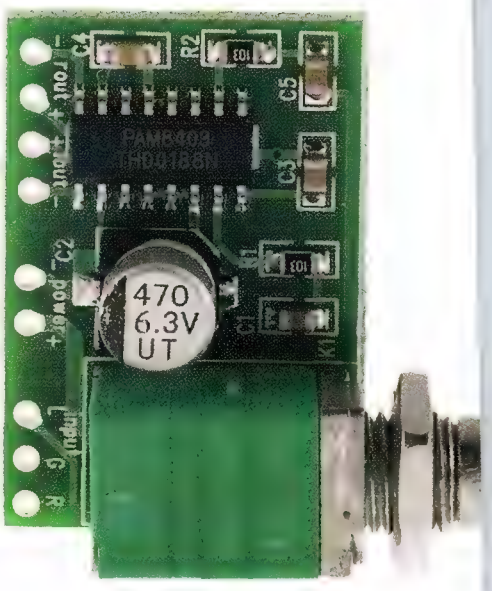
The MG90 servo motor has sturdier metal gears suited to walking bots.



This MicroSD card module has voltage translation for 5VDC microcontrollers.



The MPU6050 combines accelerometer and gyroscope to measure movement.



This SD card-sized PAM8403 3-watt stereo amp will make a racket on 5VDC.

Your phone has this technology, now your DIY gadgets can, too.

MOTORS

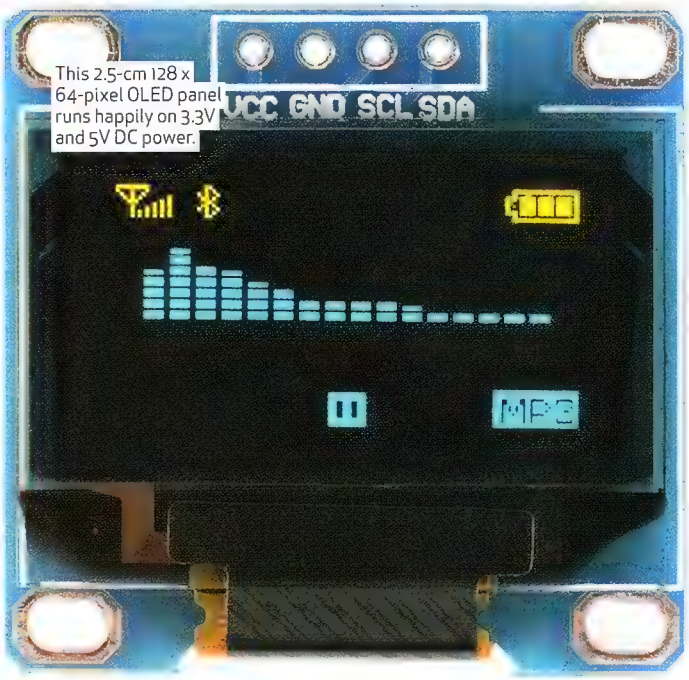
The yellow 'TT' DC geared motors have long been popular with DIY robotics and feature a standard '130' DC motor that runs on 3-6VDC. These motors are available with different gear ratios, ranging typically from 1:48 to 1:120 (the higher the gearing, the more torque but the slower it runs), so choose carefully. Meanwhile, walking robots usually need a non-continuous rotation motor called a 'servo' motor – the SG90 is as cheap as they come, but having plastic gears, it'll work but won't take rough treatment. The more-expensive MG90 has metal gears but still only a tiny motor, so they're a bit tougher but not by much. Either way, they're less than $5 each online (you'll need at least two servo motors per leg). The motors typically used in CNC (computer numeric control) machines and 3D printers are larger 'stepper motors' – they're a more complex double-coil motor that rotate in precise steps per revolution. Many dual-channel DC motor driver modules will control a single stepper motor. However, most NEMA-class stepper motors require a motor driver to supply at least 1-amp of current per coil.

MOTOR DRIVERS

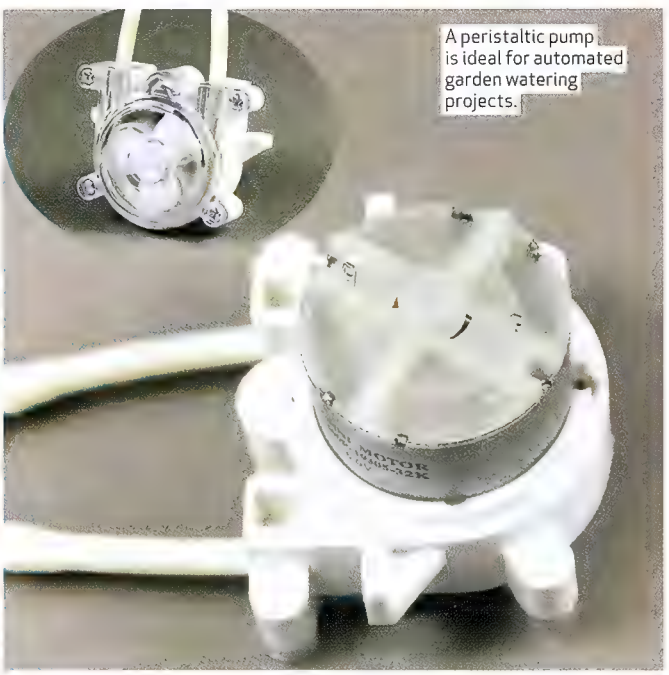
Servo motors can be driven directly by most microcontrollers, but geared DC motors and stepper motors need a driver module. The L293 dual-channel chip can handle two small DC motors and is available as a twin-chip Arduino Uno shield, handling up to 600mA continuous current per channel. Smaller again is the L9110S module – it handles two DC motors with claimed current drive of 800mA per channel. Still, these chips are tiny, so don't allow your motors to stall or the extra current drain may blow up the chips. The new DRV8833 twin-channel module has twice the grunt of the L9110S and L293 (around 1.5-amps per channel) and should handle the standard 'TT' motors well. For more powerful motors, go for the heatsinked L298 – it's still cheap, but handles continuous motor currents of up to 2A per channel (two DC motors).

WATER PUMPS

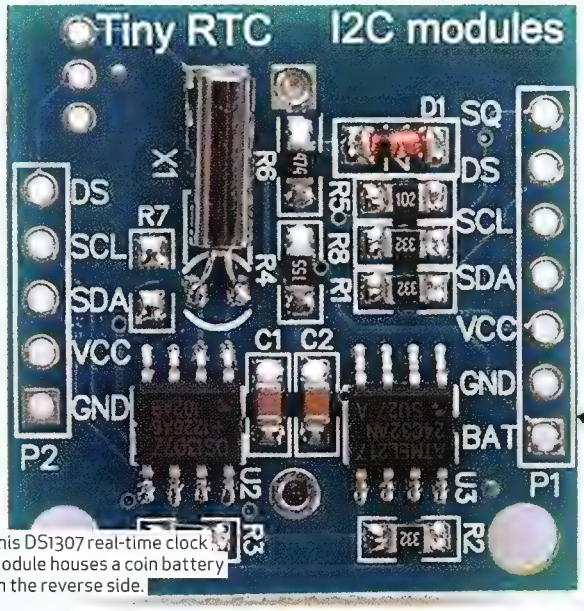
Many water pumps are just based on DC geared motors but if you choose



This 2.5-cm 128 x 64-pixel OLED panel runs happily on 3.3V and 5V DC power.

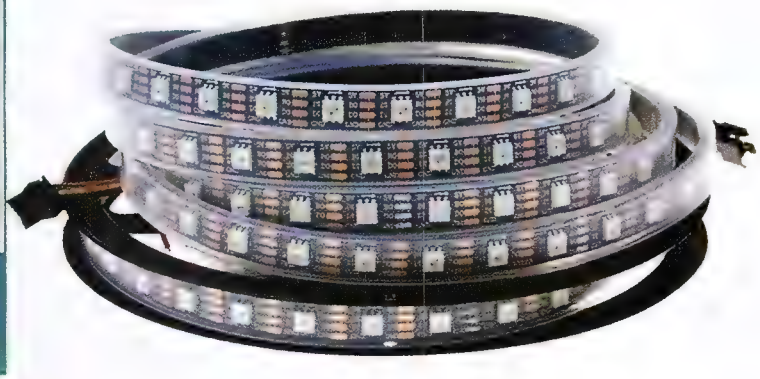


A peristaltic pump is ideal for automated garden watering projects.



This DS1307 real-time clock module houses a coin battery on the reverse side.

Flexible WS2812 RGB strips are easy to use, but watch the power draw.



a 'peristaltic pump', the water never actually touches the motor – it uses peristalsis, pressing on a flexible silicon tube looped inside the pump with roller-like bearings to push water through (the same concept is used in heart-lung machines). Small peristaltic pumps running on 6V/400mA power and pushing up to 60 millilitres per minute start from around $8 online (you can drive small pumps with any of the above motor drivers and they'd be suitable for automated watering systems).

DISPLAYS

OLED

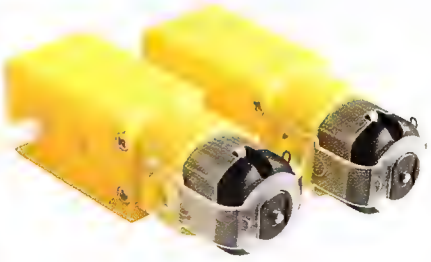
The generic 128 x 64-pixel 0.96-inch OLED display is terrific, it's not only sharp and bright, it also works with both 5VDC and 3.3VDC microcontroller boards without modification. They're generally only monochrome in colour, though.

LCD

If you want to display images, an LCD module is required. Smaller low-res LCD modules can operate via SPI (serial peripheral interface), requiring fewer I/O pins and work well with Arduino Nano-style boards. Anything beyond 2.5 inches in size will usually require an 'Arduino Mega' style of board, with plenty of available I/O pins.

ALPHALCD

The popular '1602' 16-character-by-2-line LCD modules are great for providing device status data. While the Arduino Uno-style 'shield' boards are popular, you can combine a 1602 LCD display with a dedicated I2C (inter-integrated circuit) driver module that requires just two I/O pins and works nicely with Arduino Nano and similar boards. And yes, they're 5V-happy, too.



These TT motors are great for robots and come with different gear ratios.

LEDS

Most 5V-ready Arduino boards like the Nano can deliver up to 40mA of current per pin, enough to handle discrete low-power LEDs via a current-limiting resistor. But for more 'pop', the WS2812B is a smart 'RGB' LED module – you control it directly from a single I/O pin with power applied separately. What's cool about these is that you can control up to 300 of them with just one wire. If you want to pimp up your PC case, an Arduino-controlled WS2812B strip can provide its own entertainment. Just beware of the electrical current drain – 60mA per WS2812B LED showing full-white adds up quickly even just over 30 LEDs.

SOFTWARE LIBRARIES

Connecting up a sensor or a device driver to a microcontroller is the first step – you'll also very likely need software libraries that allow the microcontroller to talk to the add-on. In many cases, the easiest option here is to use the Arduino IDE's Library Manager.

First, launch the Arduino IDE (get it from **arduino.cc/downloads**) and from the main menu, select 'Sketch', then 'Include Libraries' and 'Manage Libraries'. When the Library Manager window appears, type in the model number of the main chip on your module and, chances are, you'll find one or more library options. Just check first with online forums that your particular module will work with that library – some libraries are generic (work with all modules with that chip), others can be more specific. Like most DIY projects, expect to hit a speedbump or two along the way, but a quick Google search will usually point you in the right direction.

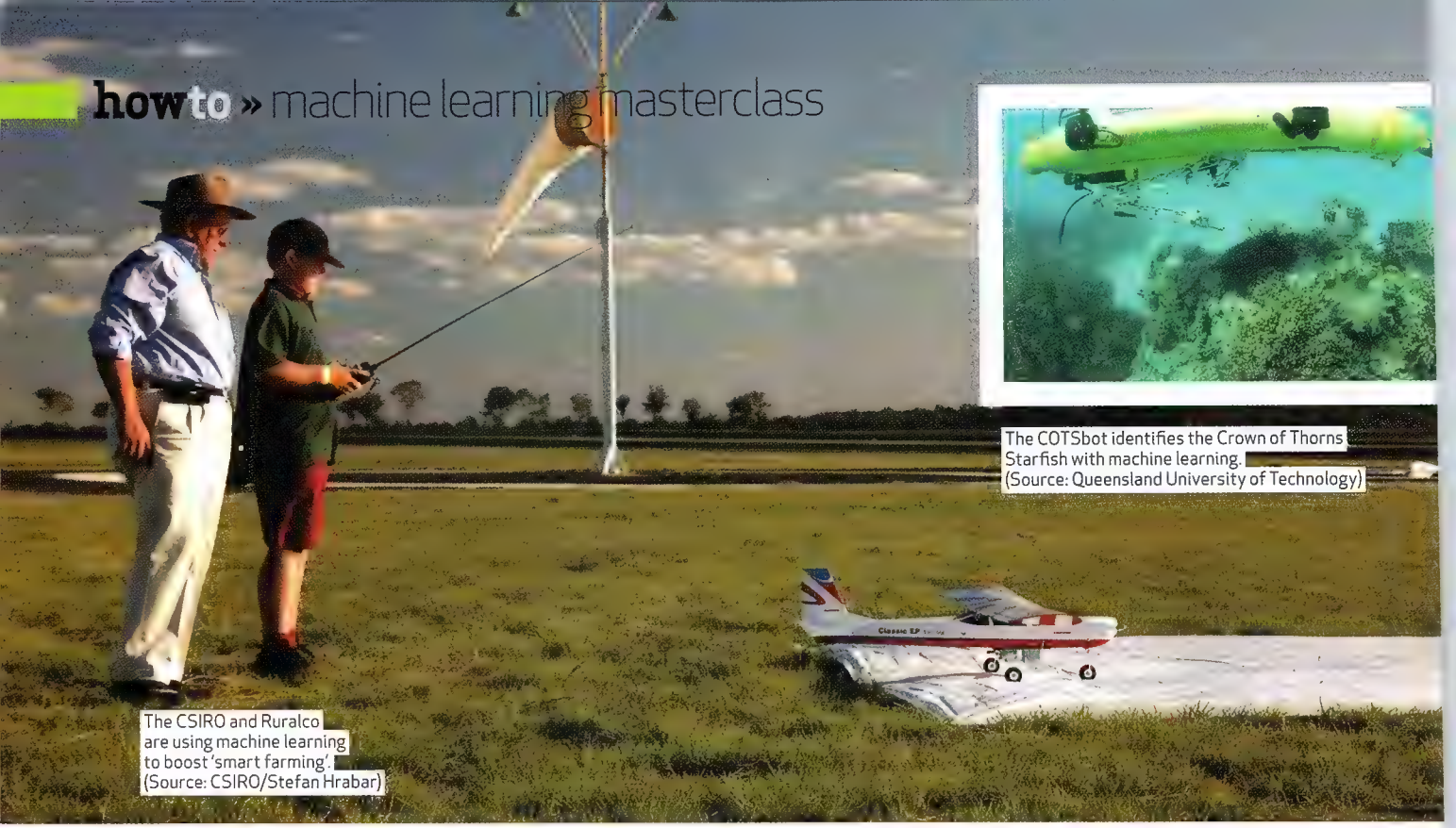
Once you've installed the library, check back in the Arduino IDE's 'File' menu under 'Examples' – many libraries provide examples to help you understand how they work.

LEARNING ELECTRONICS

While sensor modules are great, the reality is you can connect up just about anything to a microcontroller, provided you understand the connection and power requirements of all devices. For example, driving a garage-door motor straight from an Arduino I/O pin isn't going to work, but once you understand the power of discrete electronic components, you'll be able to design your own connection method that keeps everything happy (hint: MOSFETs are well worth getting to know!).

Learning discrete analog electronics is a bit of a dying art these days, but if you want to really let your inner electrical engineer loose, having these skills provides you with so many more design choices – think of it as going from 256-colours to 32-bit colour.

Bottom-line, if you can code and design your own electronic circuits, there's not much you can't do. ■



The CSIRO and Ruralco are using machine learning to boost 'smart farming'. (Source: CSIRO/Stefan Hrabar)

The COTSbot identifies the Crown of Thorns Starfish with machine learning. (Source: Queensland University of Technology)

Machine Learning 101

Artificial intelligence is taking the world by storm. In this new series, Darren Yates delves into the inner world of machine learning, how it works and how you can do it.

The concept of 'artificial intelligence' is driving almost everything at the moment, from cars to healthcare to smart speakers to smart farming. Yet, we say 'concept of' because artificial intelligence itself has become a bit of a 'catch-all' phrase for anything to do with computers and learning. Nevertheless, when Google recently announced it was transitioning into an "AI-first" company, much of that focus is being trained on the field of 'machine learning'. It's one of the top hot-button topics in the tech world at the moment and the scene of vast amounts of university research. However, what we love about machine learning is that it's also an intensely practical field – this intersection of computer science, statistics and mathematics is being applied to problems in a seemingly endless array of human endeavour from medicine to autonomous cars. What's more, it's something you can learn and even do on a PC.

In this new series, we'll unpack the basics of machine learning – what it is, how it works and hopefully, give you a taste of how it's being used and changing how we live.

GET THE TOOLS

If you've followed our previous coding series, you'll know we're always on about being practical. This machine learning series will be no different. We'll be using a range of free software throughout, including Python, the 'R' statistical programming language and the Weka data-mining suite. There are many other tools you can use, from Microsoft Excel to industrial-scale statistics and analytics environments such as SPSS and Hadoop. However, if you can understand the algorithms that drive machine-learning, you can use almost any programming language you like. Nevertheless, to keep things under control, here's what we'll stick to:

WEKA: **www.cs.waikato.ac.nz/ml/weka** (requires Java run-time)

RStudio: **www.rstudio.com/products/rstudio/download** (free open-source 'desktop' version, but you must first install 'R', **cran.r-project.org/bin/windows/base**)

Python: **www.python.org/downloads**

Each of these is available for Windows, macOS and Linux, but again, to keep things manageable, we'll be describing the Windows versions of these tools wherever possible.

Python and 'R' are two of the most popular languages for machine learning, while Weka is a popular GUI data-mining suite, developed by New Zealand's University of Waikato.

WHAT IS MACHINE LEARNING?

Let's dive in at the deep end. Machine learning itself is a broad field yet focuses on using computer algorithms to discover patterns within potentially mountains of data – so-called 'big data'. In addition to learning patterns or 'rules' about the initial data, those rules may then also be used to make predictions about similar previously unseen data (for example, weather forecasting).

In simple terms, an algorithm is a recipe for a specific task and just as there are many recipes for 'chocolate cake', there are many algorithms available for machine-learning tasks. One of the most popular machine-learning techniques is the 'decision tree' – it's an area Australia has a long history in, thanks to the work of Ross Quinlan, a computer scientist with the University of Sydney and University of Technology, Sydney (UTS) during the 1980s and 1990s.

In 1993, Quinlan released C4.5, one of the most popular machine-

learning and data-mining algorithms created.

How does machine learning differ from data-mining? Some use 'machine-learning' and 'data-mining' interchangeably, others see them as completely different areas, while others again consider them as two sides of the same coin. Essentially, they're both about finding information from data. We're generating so much data now that it's well past our ability to make inferences from that data just by looking at it. One way you can describe these two areas is that machine-learning is the specific process of using computational statistics to find patterns within data, while data-mining is the broader process of selecting, gathering and digging into or 'mining' that data for knowledge.

THE RIGHT DATA

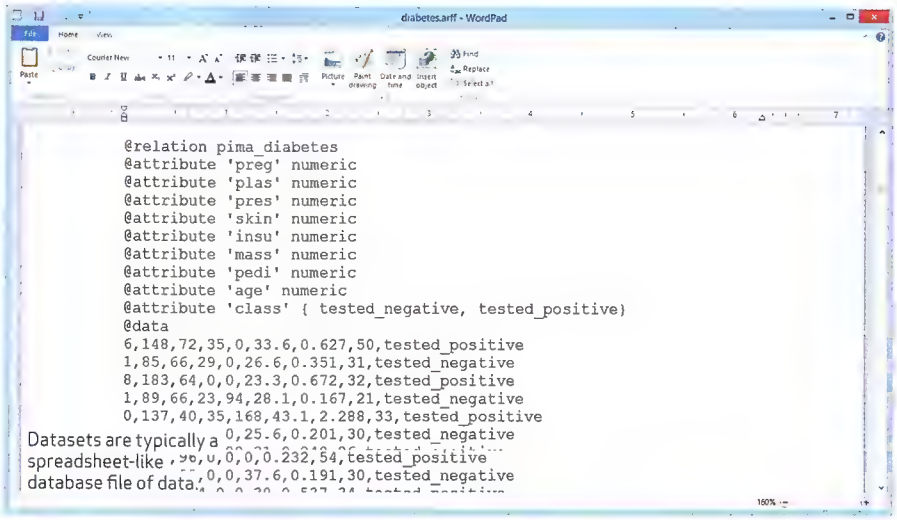
Any chef will tell you the best results always come from having the best and freshest ingredients. The same goes for machine-learning – it's impossible to overstate the importance of starting with high-quality data and with so much data around now, you could argue it's getting harder to find good data. This is a growing issue facing CEOs and other business leaders. Why would they care? Machine-learning and data-mining are increasingly being used to help executives make informed business decisions, an area called 'business intelligence'.

In terms of data mining, you need to start with data that makes sense, that involves features or 'attributes' that have potential for some meaningful relationship. There's a popular graph that shows an apparent relationship between the US per capita consumption of margarine and the divorce rate in the US state of Maine between 2000 and 2009 (**tylervigen.com/view_correlation?id=1703**). The two lines are in almost perfect lock-step, but the apparent 'relationship' is meaningless.

In practice, you'll likely spend far more time obtaining and wrangling good data than you will running machine-learning algorithms.

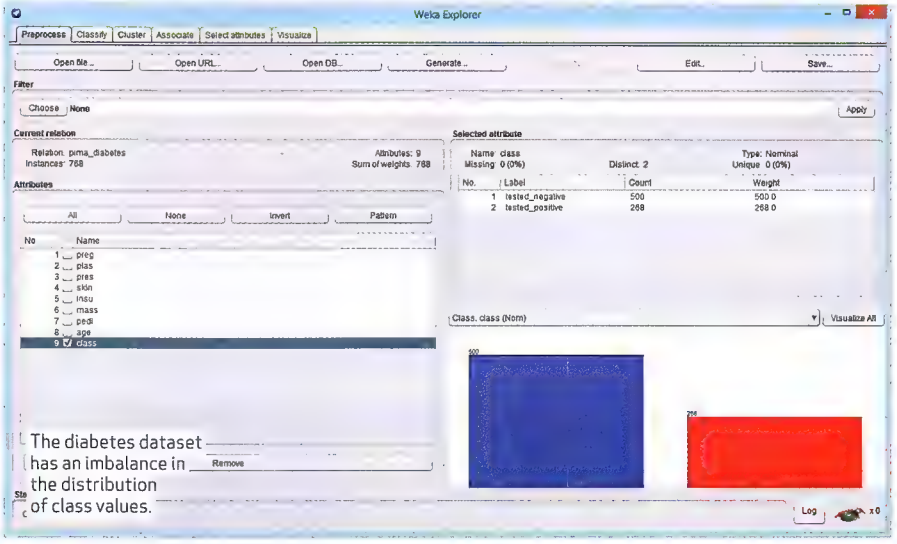
TYPES OF LEARNING

Getting back to machine learning, there are generally two main classes of learning – supervised and unsupervised. In supervised learning, the learning algorithm starts off with a training set of data or 'dataset' that looks like a spreadsheet – coming down in rows are records or 'instances' of similar events, each instance recording a single event, while across the columns, you have the various features or 'attributes' of those events. For example, say we have an anonymised training dataset of patients tested for diabetes

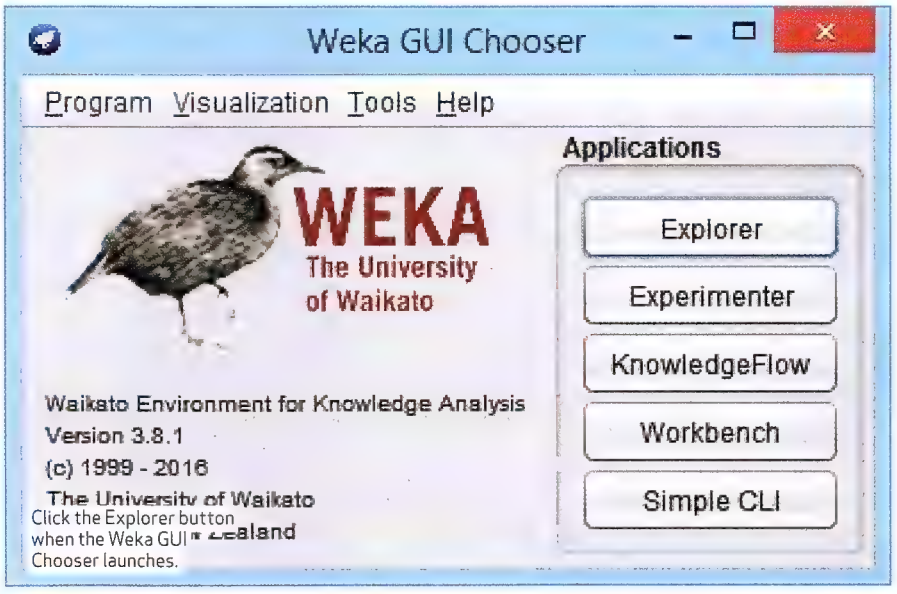


Datasets are typically a spreadsheet-like database file of data.

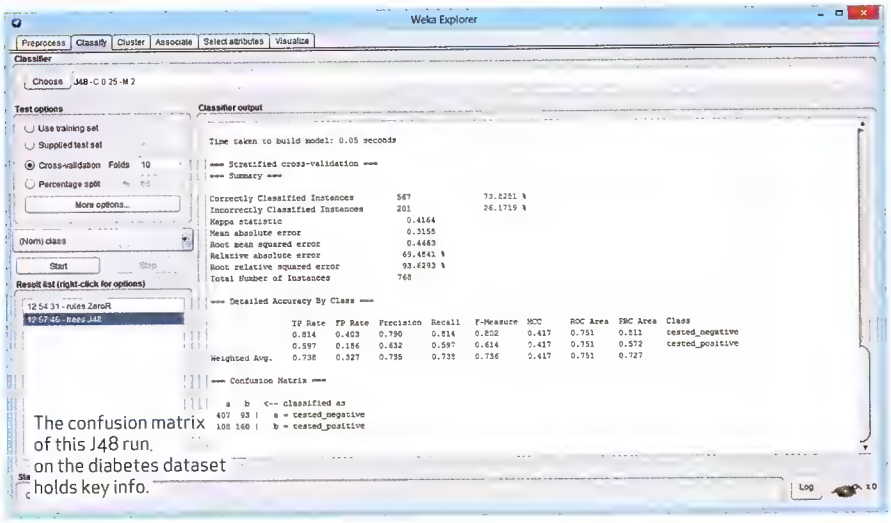
"An algorithm is a recipe for a specific task and just as there are many recipes for 'chocolate cake' there are many algorithms available for machine-learning tasks."



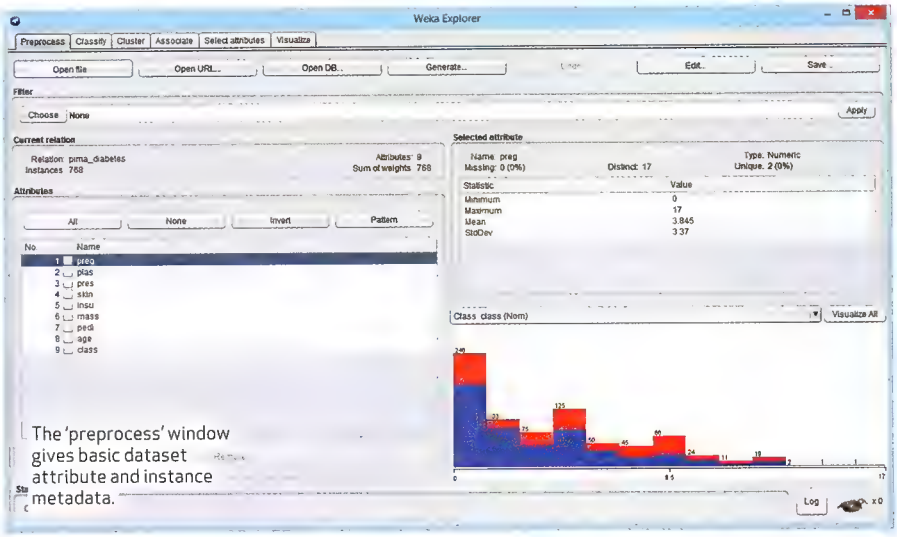
The diabetes dataset has an imbalance in the distribution of class values.



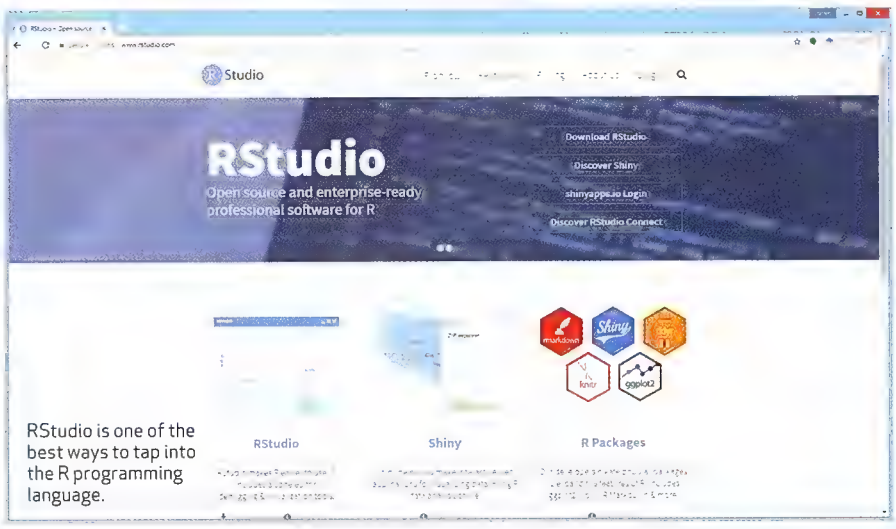
Click the Explorer button when the Weka GUI Chooser launches.



The confusion matrix of this J48 run, on the diabetes dataset holds key info.



The 'preprocess' window gives basic dataset attribute and instance metadata.



RStudio is one of the best ways to tap into the R programming language.

('anonymised' means individual patients cannot be identified from the data) – each row represents one patient and each column is an attribute of that patient, such as age, body mass index (BMI), diastolic blood pressure and so on. In supervised learning, one of those attributes will be a categorising or 'class' attribute. In this diabetes example, this class attribute could be whether or not the patient had diabetes. Using machine-learning, we can identify possible patterns or 'rules' linking patient attributes to the onset of diabetes and together, these rules form a 'model'. This is broadly called 'knowledge discovery'. However, the extra value here is that the 'model' learned may then be able to predict a future or 'unseen' patient's diabetes diagnosis – this predictive ability of machine learning is just one reason why it's pretty hyped at the moment.

This is an example of 'supervised learning' because it starts with a training dataset where the class attribute value for each instance is already known, each record has already been categorised. Another name for this learning type is 'classification' analysis, since it involves finding patterns that group the records into their discrete categories or 'labels' (for example, 'has diabetes' or 'doesn't'). If the class attribute was, instead, a continuous or decimal number, we'd be looking for a mathematical equation that accurately mapped the relationship between the attributes – this is 'regression' analysis.

If supervised learning starts with a training data set where the class attribute value for each record is already known, 'unsupervised' learning starts with just a dataset that has no class attribute, requiring different learning methods.

REAL-LIFE EXAMPLE

The diabetes example we've used is actually a real-life example. The University of California, Irvine (UCI) keeps a repository of publicly available anonymised datasets for machine learning (**archive.ics.uci.edu/ml/datasets.html**) and the diabetes dataset was donated to UCI by the Applied Physics Laboratory of John Hopkins University. It contains 768 anonymised female Pima Indian patient data records, each with nine attributes, including a class attribute indicating whether or not the patient had diabetes. This dataset is also bundled into the Weka data-mining suite.

If you haven't, download and install Weka 3.8.2 from the link. When you're ready, launch Weka, click on the Explorer button and when the Weka Explorer appears, ensure the 'preprocess' tab is selected and press the 'Open file...' button. In the Weka install folder under 'Program Files', you'll find a subfolder called 'data'. Open it and choose the 'diabetes.arff' file. WEKA Explorer allows you to run machine-learning/data mining algorithms on data using a graphical user interface. The left-side of this pre-process screen shows the basic dataset properties and attributes, the right-side shows basic statistical details of each attribute you click on.

Here, the nine attributes are 'preg' (the number of times pregnant), 'plas' (plasma glucose concentration), 'pres' (diastolic blood pressure), 'skin' (skin fold thickness), 'insu' (two-hour insulin level), 'mass' (body mass index), 'pedi' (diabetes pedigree function), 'age' (in years) and 'Class' (negative or positive).

With 768 records, each with nine attributes, that's 6,912 points of data – far more than our human minds

can cope with, but we can use machine-learning to find any hidden patterns that may tell us how these attributes relate to diabetes diagnosis.

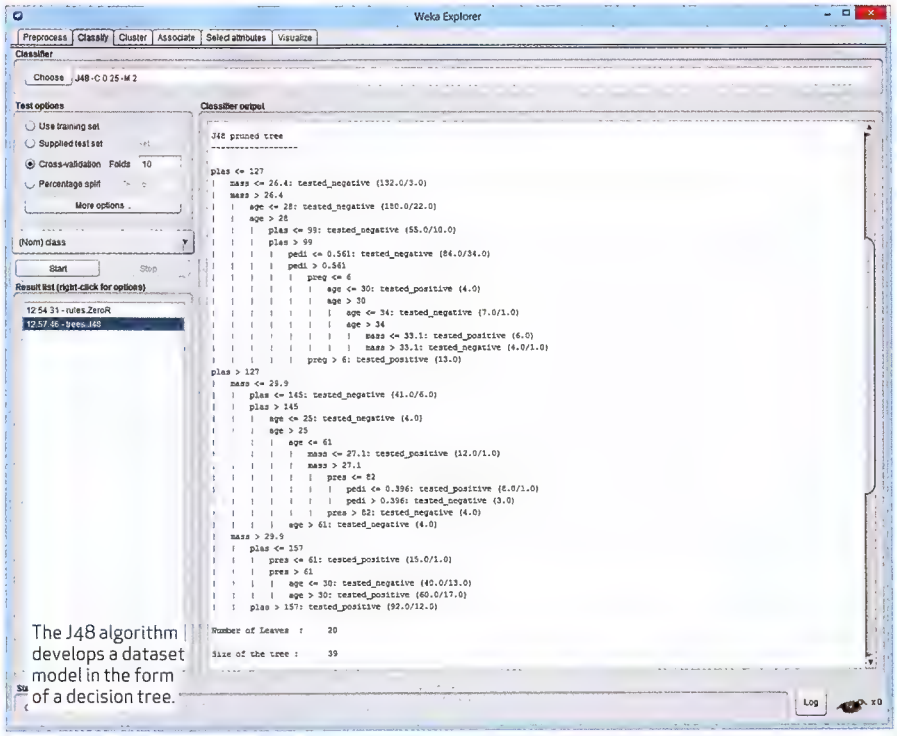
In Weka Explorer, click on the Classify tab, press the Choose button, select Rules from the drop-down list and click on 'ZeroR'. Now press Start. ZeroR stands for 'zero-rule' and really just marks the classification accuracy baseline – any decent algorithm should better a ZeroR result. Go back to the Preprocess tab, click on the Class attribute in the left-side list and on the right-side, you'll see two columns – of the 768 records, 500 of them were classified 'tested-negative' (blue), and 268 'tested-positive' (red). In other words, 500 patients did not have diabetes, but 268 did. If you're using this data as a predictor for which patients will or won't have diabetes, ZeroR is really a blunt instrument – it says just select the majority class value (the one with the greatest number) and apply that to every patient. Since 500 patients didn't have diabetes and 268 did, ZeroR goes with 'tested-negative'. Go back to the Classify tab, scroll through the output and you'll see that the classification accuracy for ZeroR ('correctly classified instances') on this dataset is 65.1042%, or 500 out of 768. It's saying that, based on the training dataset, if you decided that all patients did not have diabetes, you'd be right 65.1042% of the time. How good is that? Well, if you consider 50% is the equivalent of tossing a coin, 65.1042% has to be better, right? Maybe for those who don't have diabetes, that rule is fine, but not for those who do.

From a machine-learning perspective, ZeroR sets the baseline classification accuracy here at a better-than-coin-toss 65.1042%, but that's only because we had 500 of 768 records test as 'negative'. If it were 500 out of 1,000 records, we'd be back to 50% accuracy and tossing a coin. It's an example of a broader issue called 'class imbalance' that we'll look at another time.

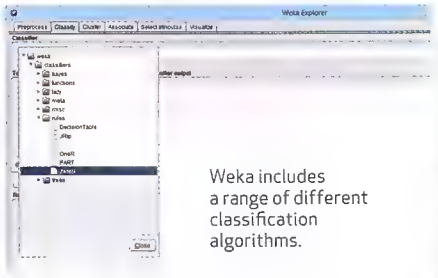
Meanwhile, click on the Choose button under the Classify tab, select Trees from the drop-down list and choose 'J48'. This is Weka's implementation of the C4.5 decision tree algorithm we mentioned earlier. Click the Start button and you'll see that J48 produces a set of rules or 'model' with an improved classification accuracy of 73.8281%. It reveals this model as a decision tree outlining the (complex) relationship between the attributes and the class (how it does this, we'll look at another time, too).

COST SENSITIVITY

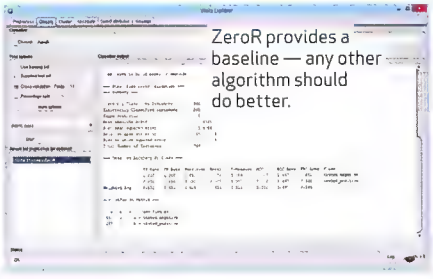
However, we can also learn more by looking at the 'confusion matrix' at the bottom of the J48 output screen. No doubt you've seen antivirus



The J48 algorithm develops a dataset model in the form of a decision tree.



Weka includes a range of different classification algorithms.



ZeroR provides a baseline — any other algorithm should do better.

software report 'false-positives', or apps having a virus when they don't. A 'true-positive' is when an antivirus app correctly identifies and reports malware, while a 'true-negative' is when it doesn't report an app that isn't malware. A 'false-negative' is the antivirus declaring a malware app is malware-free.

Classification in general works similarly and this is shown by the confusion matrix. In this case, the confusion matrix shows the numbers of 'tested-negative' and 'tested-positive' records and how they were re-classified using the model as either 'tested-negative' or 'tested-positive'. Ideally, you want all 'tested-negative' records re-classified as 'tested-negative' and all 'tested-positive' records as 'tested-positive' to give you 100% accuracy.

If you look at the top row of the matrix (opposite), it shows that, of the 500 'tested-negative' (a) records, 407 were correctly classified as 'tested-negative' and only 93 were false-positives, that is, 'tested-negative' records incorrectly classified as 'tested-positive' (b). However, of the 268 actual 'tested-positive' (b) events, 160 were correctly classified as 'tested-positive', but 108 were falsely classified as 'tested-negative' (a). If we'd relied on this model alone, we'd be saying 108 patients didn't have diabetes when they really did.

This is also an example of 'cost sensitivity'. Diabetes is just one of many health issues where a false-negative is far more costly than a false-positive – of the two, you'd rather be told you had diabetes when you didn't, as untreated diabetes typically leads to serious health complications.

However, given this model is only 73.8281% accurate overall, we need to investigate further – either adjust the model to see if greater accuracy is achievable or the dataset itself maybe lacking some key patient attribute.

CAREFUL APPLICATION

Machine learning can provide valuable insight into data, but the learning can depend as much on the algorithm used as on the quality and relevance of the data fed into it.

This has been a broad introduction to give you a feel for machine learning and over the coming months, we'll explore various techniques and methods for learning from data. We won't promise you'll become a machine learning guru reading this series, but you should gain an appreciation for why machine learning is such a hot topic. ■

apc HOT PRODUCT

PS4 | $94.95 | PLAYSTATION.COM/GODOFWAR

God of War

Kratos is great at raising hell, but can he raise a son?

It's been many years since Kratos exacted bloody vengeance on the Gods of Olympus for tricking him into murdering his own family, and he's changed in quite a dramatic way. The Spartan warrior has left Ancient Greece behind and is now living a peaceful life with new family in the Norse realm of gods and monsters.

But it's not just the Norse mythology setting that sets the new *God of War* apart from previous entries in the series – its action-focused gameplay has been completely deconstructed and reimagined, offering a new over-the-shoulder camera perspective and an axe-based combat system that keeps Kratos mostly grounded. He's also got a companion along for his latest adventure, with his young son Atreus providing backup with his trusty bow and knife during combat, while also deciphering Norse text and helping out with puzzles.

This father and son duo is bound to draw comparisons to Joel and Ellie from Naughty Dog's 2013 masterpiece *The Last of Us*. It displays a maturation of character and tone that helps take the series to new emotional levels, making for a much deeper and more satisfying overall experience.

Perhaps inspired by the likes of *Dark Souls* and *Bloodborne*, the new combat system's quick and heavy attacks are mapped to the R1 and R2 shoulder buttons, with added functionality, like axe-throwing, granted while holding the aim button (L2). Aiming at an enemy and pressing the square button will also cause Atreus to shoot arrows for you – an invaluable tactic later in the game when the bow is powered up with numerous magical abilities.

Thankfully, the combat, though occasionally tough, is much more accessible than it is in the *Souls* games; this is still a *God of War* title at heart. As you level up and upgrade your abilities, weapons and armour, you become more formidable, able to take on multiple enemies at once.

In stark contrast to the mostly-linear nature of previous *God of War* games, this iteration takes a page out of the *Tomb Raider* reboot playbook, giving you a much larger environment to move around in without going all the way into sandbox territory. In true Metroidvania fashion, certain areas, items and pathways are initially blocked off to Kratos and son, opening up only after you've unlocked the requisite new ability or weapon which allows you to break through previously unbreakable barriers.

The new *God of War* isn't just the best game in the series to date because of its redesigned combat system, updated camera, epic scope and incredible visuals. Like its characters, it reaches such incredible new heights because of the inclusion of something that none of the previous titles in the series really had much of – heart.

■ Stephen Lambrechts

Verdict

As emotionally affecting as it is brutal and action-packed, this is one of the best games of all time.

★★★★★

Combat is simplistic compared to the first *Ni No Kuni*, but it's still a lot of fun.

PC, PS4 | $99.95 | WWW.BANDAINAMCOENT.COM

Ni No Kuni 2: Revenant Kingdom

A massive JRPG designed for newcomers to the genre.

When it released in Australia back in 2013, *Ni No Kuni: Wrath of the White Witch* represented a rare, mainstream moment for JRPGs, receiving the kind of attention normally reserved for *Final Fantasy* games. The reason was its pedigree: while its status as a new Level-5 game was only of interest to diehards, Studio Ghibli's attachment to the project was key. The studio is, after all, best known as the animation crew responsible for *Spirited Away*, *My Neighbor Totoro*, *Ponyo* and more. It was like a match made in heaven.

But *Ni No Kuni 2: Revenant Kingdom* can't lay claim to any Studio Ghibli association, so its arrival feels muted. Perhaps to compensate for this, Level-5 has transformed the *Ni No Kuni* series from a prickly turn-based JRPG into... a game that basically tries its hands at everything, with its sights fixed firmly on a more casual audience. The turn-based combat is gone, replaced with a simplistic but nonetheless fun live-action system with the usual light / heavy attack and stamina management formula.

While Studio Ghibli isn't responsible for cutscenes this time around — the game is still lovely looking.

And that's not all — the game's typically grandiose JRPG formula is augmented by a kingdom building element, which proves a lot more complicated and feature-heavy than you might expect. This dovetails with the plot: you play as Roland, who has witnessed the destruction of a city and, afterwards, is whisked away, transformed and tasked with rebuilding a (much more whimsical) fantasy kingdom. It's a JRPG, so the story is several orders of magnitude more complicated and bloated than that, but the setting is gripping enough to carry you through what is, at heart, a fairly breezy game. Because it's true — *Ni No Kuni* appealed to JRPG fanatics, whereas its sequel wants to appeal to everyone.

Those seeking a stiff challenge may be disappointed, but the game is beautiful and charming enough to compensate for its easiness, even if by the halfway point, it reveals itself as a confection, rather than a hearty JRPG meal.

■ Shaun Prescott

Verdict

A fun and vibrant JRPG which can be enjoyed by folk unaccustomed to the genre.

★★★½☆

Metal Gear Survive

Solid, but no snake.

PC, PS4, XO | $69.95
WWW.KONAMI.COM

Despite the troubled circumstances of its development, this isn't as far away from a classic *Metal Gear* game as it seems. The strangest thing is how much a game marketed as a co-op experience actually focuses on its surprisingly robust single-player mode.

Survive stars a grunt in the private army of Big Boss. Following the events of 'Ground Zeroes', your character is left for dead. A mysterious character called Goodluck recruits you to travel into a parallel dimension ruled by a parasitic life-form that turns the dead into crystallised nasties. You have to make your way home and rescue survivors. It's is still a stealth game, lifting the highly praised mechanics of *The Phantom Pain* and transplanting them into a horror-themed survival world. It's surprising just how well the survival angle suits the gameplay. There's a sense of danger that wasn't really present in *The Phantom Pain*, too.

But where you're likely to spend a lot of your time is the online co-op mode, where the main objective is to secure and plant a 'wormhole digger', and defend it against several waves of enemies.

For those who want a solid open-world game with polished stealth and survival elements, this is a game that doesn't just survive, it thrives.

■ Sam Greer

★★★½☆

Age of Empires: Definitive Edition

Tries to hide its age, but can't...

PC | $23
WWW.AGEOFEMPIRES.COM

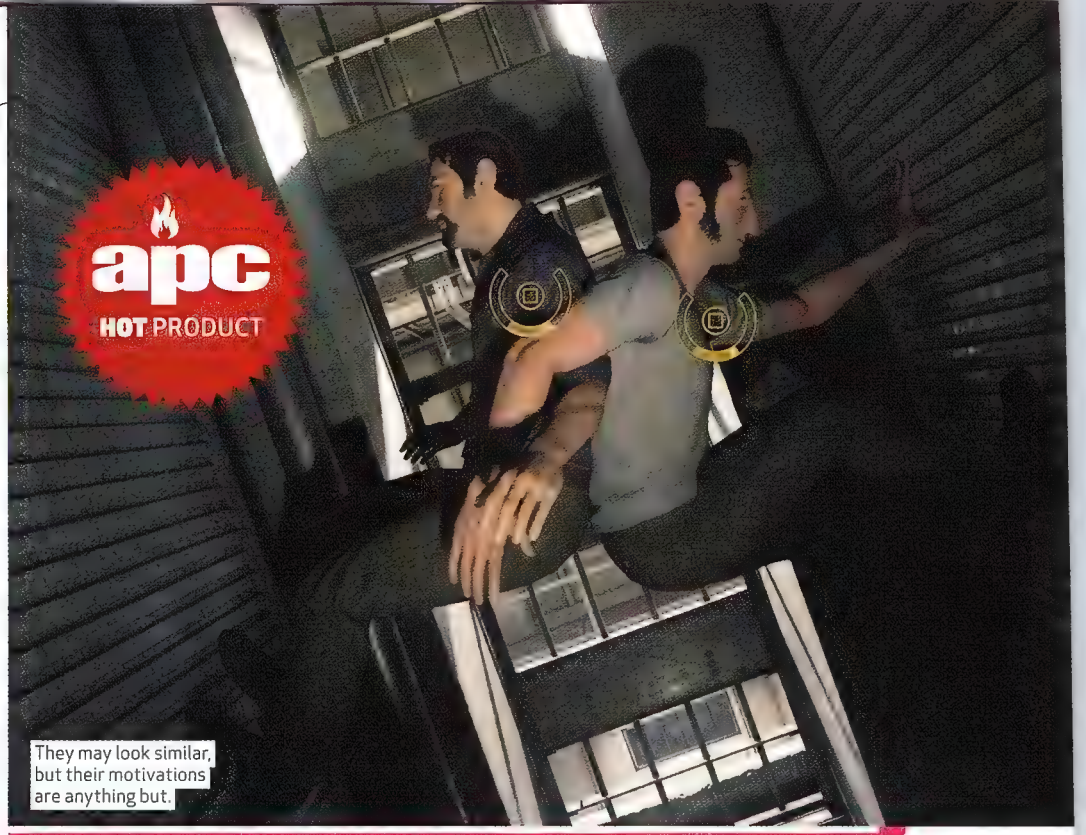
The first *AoE* introduced the world to Ensemble's *Warcraft*-meets-*Civilization* concept and got a good two years in the spotlight before being outshone by its follow-up. Two decades since its launch and it's been resurrected. *Age of Empires: Definitive Edition* is prettier and slicker, but it's still not as good as its sequel. The visual upgrade is an overhaul rather than just a bit of HD polish, full of new art and animation, but it's all in keeping with the original style. And it goes beyond aesthetics; the game's simply cleaner and easier to parse. The result is that it certainly doesn't look 20 years old, but neither does it look completely new.

The systems that set it apart, things inspired by *Civilization*, were a bit half-baked in 1997, with trade, diplomacy and research existing in name only. The focus is on micromanaging lots of fiddly units and constant expansion. A mountain of maps and objectives can't disguise that you're playing with the same small deck of cards in every campaign.

If you have a sense of nostalgia about the birth of the series, this does a great job of preserving it while making its flaws considerably more palatable, but for a trip down memory lane, it's probably better to wait for the sequel's remaster.

■ Fraser Brown

★★★



They may look similar, but their motivations are anything but.

PC, PS4, XO | $39.95 | WWW.EA.COM/GAMES/A-WAY-OUT

A Way Out

Co-op like you've never seen it before.

Being able to play a game in co-op feels like a nice added bonus. It's rare that a game is designed specifically to be played cooperatively – in fact, here, you can't play without another human by your side or across the internet. From the same brain that created *Brothers: A Tale Of Two Sons*, this is another narrative-driven co-op adventure, one designed to be experienced together. And if you do, you'll be rewarded with one of the most cleverly designed storylines in gaming yet.

You play as one of two prisoners looking, literally, for a way out. Leo's already in jail for armed robbery, assault and grand theft, whereas Vincent has just started his sentence after getting time for fraud, embezzlement and murder. But despite their crimes, you very quickly come to bond with the two. The story does well to flesh out both their backstories, their motivations and their personalities, and this plays into how you interact with the storyline. Leo's hotheadedness can take you down a more violent path, while Vincent's calmer approach is often a better alternative for not drawing attention to the escapees.

The variety and ingenuity of all the co-op moments available in *A Way Out* proves that playing together doesn't have to be just part of a gameplay experience, it can be the *entire* experience.

There's plenty of intrigue in the two characters, and in watching them move from two strangers to a pair that have to work together to succeed. From car chases to shootouts, there's enough action to keep you constantly moving from scene to scene, plus there's a nice blend of story and puzzle solving.

The only thing that does let *A Way Out* down is its over-reliance on quicktime events in the opening hour or so. This becomes less of an issue as you progress, but initially, it can feel like Hazelight has a QTE obsession.

But it's a joy to play 99% of the time, particularly in splitscreen, with the viewing windows changing and rotating depending on the situation, while camera angles play with various perspectives to make sure that, even when there's only one character on screen, the transition between the two is as cinematic as possible. One moment you're playing as Leo, hitting cops in the face with a lampstand, the next the camera is soaring through air vents and down corridors to find Vincent hiding from cops at the hospital's reception. From the cinematics to the smallest minigame, *A Way Out* elevates co-op gaming in a way no other game has done to date, making every action feel meaningful rather than a cheap gimmick.

The toughest hurdle here is to get you playing. The fact you have to play this with two people will put a lot of players off, but if you leave this one unplayed, you're denying yourself (and your friends) one of the best adventures around.

■ Samantha Loveridge

Verdict

Makes co-op gameplay more worthwhile than anything else before it.

★★★★½

The world might be as dark and as miserable as ever, but it's never looked so good.

apc HOT PRODUCT

PC, PS4, XO | US$30 | WWW.VERMINTIDE.COM

Warhammer: Vermintide II

Mickey Mouse clubbed house.

The original *Vermintide* was a delightful *Left 4 Dead* clone that put the fantasy trappings of the *Warhammer* universe to excellent use. Instead of boring old zombies, we got to battle hordes of ratmen called Skaven and instead of just shooting our way through, there was robust melee combat.

Vermintide II is a massive overhaul that polishes what was there before to a fine sheen while adding huge amounts of variety.

After halting the plans of Clan Fester in the original game, our heroes were captured. This game begins with you breaking out of captivity, in an elaborate tutorial level, just in time to discover that the Skaven have now joined forces with the barbarian Chaos Warriors from up north. Now it's up to our heroes to thwart their nefarious plans and postpone the end of the world for a second time.

The inclusion of these demon-worshipping killers is the major shake-up to Vermintide's formula. Where the Skaven are small and nimble, the men of Chaos are lumbering brutes. It's tougher for them to swarm you, but each packs considerably more punch than a ratman, meaning they absolutely demand your attention in combat. The combinations created out of the two forces make *V II* a real challenge, forcing you to change tactics and priorities. Variety isn't just owed to the inclusion of Chaos; the rats themselves have been overhauled, with several types of new Skaven joining the fray.

To tackle these monsters, you'll be given the option of five heroes – the same present in the original game, but this time, they each have three distinct classes with differing skill trees. Choosing to invest in a class is a long-term commitment that comes with great rewards for those who put the time in.

And those up-close brawls feel better than ever, too. It was already a highlight of the first game, but the improved animation and feedback in the sequel is tremendous. Every swing has heft, and the feel of each weapon type is nailed. It's gory and gruesome, but in that grimly gleeful *Warhammer* way.

The main strength of these heroes isn't their fighting prowess, though, but the writing and performances behind them. Grim fantasy might usually be full of grumbling gruff types, but the heroes of *Vermintide* are real fun to be around. It really helps the co-op gameplay thrive.

There are three acts to the game, and they can be tackled in any order. Each has its own final boss, and takes you through a host of different environments – from claustrophobic ruins to wide-open farmland – and the battles feel significantly different in each location.

The level of challenge is both a boon and a curse. You get a real sense of overcoming the odds, but with no checkpoints throughout a level, repeat failures can be an incredibly frustrating experience. But that's really the only weakness here. ■ Sam Greer

Verdict

When it comes to co-op action, *Warhammer: Vermintide II* stands out from the pack.

★★★★½

apc RECOMMENDS

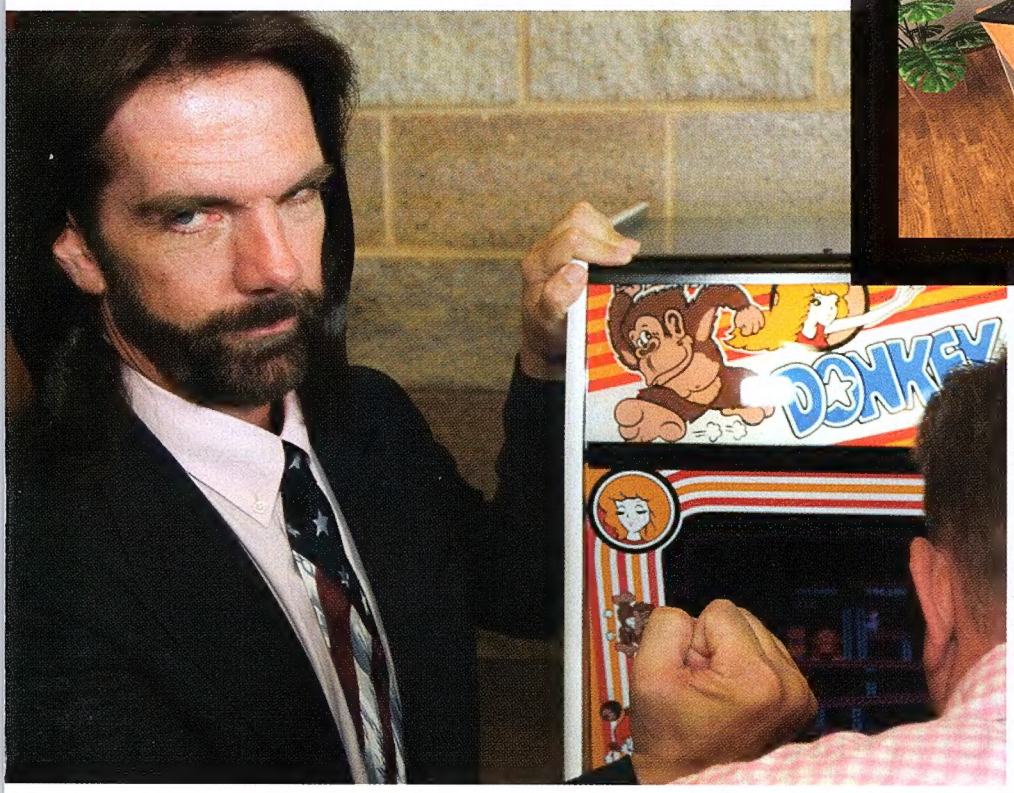
QUBE 2

It might look simple, but this puzzle game boxes clever.

PC, PS4, XO | US$25
WWW.TOXICGAMES.CO.UK

This sequel makes its predecessor feel like a prototype. It looks better, sounds better, and it's far more imaginative. From a simple foundation of three coloured blocks, it builds head-scratching puzzles that stump you for 20 minutes — and then make you feel like a genius when you stumble on the solution. You play as amnesiac architect Amelia Cross, who is stranded inside an alien structure. The only way to get out is to solve puzzles using a magic sci-fi glove. In each level, there are squares that you can paint with a wave of your hand. Blue will cause anything that hits it to bounce off, green will produce a cube that can move around the level, and orange creates a short column that can extend and retract — useful for pushing objects around.The game layers new mechanics on top of these blocks constantly. You'll soon be controlling magnets, swivelling walls, flinging yourself over gaps, coating blocks in oil and skidding them across the floor, then setting metallic balls on fire so they can bash through walls. The solutions are challenging enough to be satisfying, especially later on. It looks fantastic, too. The story unfortunately takes itself far too seriously. The buzz we got from solving ithe puzzles here will stay with us for the rest of the year. ■ Samuel Horti

★★★★★



The King of Kong has lost his crown

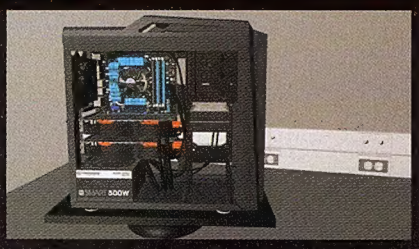
Mitchell stripped of gaming titles.

Billy Mitchell, best known as "that guy from the *King of Kong* documentary that nobody was rooting for", has been discovered to be undeserving of his Guinness World Record and gaming titles. An investigation into his highest scores in the arcade games *Donkey Kong* (in which he was the first to score over one million points), *Donkey Kong Jr* and *Pac-Man* (where he achieved the world-first perfect score from 1999) has revealed that the scores were attained on a machine using the Multiple Arcade Machine Emulator (MAME) and not an authentic arcade machine. This being against the Twin Galaxies rules (the organisation that verifies information for Guinness World Records), Mitchell has subsequently been stripped of his world records and prohibited from participating in any further attempts. According to Guinness World Records, they are currently in the process of finding "the appropriate holder of these records". Wait by the phone, gamers!

Fox releases pilot for human vs robot game show

THE OPPRESSION BEGINS.

While the details are few and far between at this stage, it has been reported that Fox has been developing a pilot for *Man Vs Robot* for two years. The premise of the show revolves around the idea of families of squishy humans pitting themselves in a 'physical' game show against robots. Described as being a bit like *Tron* and *Gladiators*, we're not entirely sure what to expect, although the idea of a human vs bot *Pong* match has been mentioned. Considering that humanoid robots are still having trouble walking without falling over, we imagine the 'physical' aspect of the show refers more to limited (probably sitting) activities, rather than races across monkey bars or shimmying up a rope, military training-style. A member of the creative team has stated that they're looking into how you can have "an emotional moment with robots", so maybe they will have a certain Chappie-like charm to entice viewers to support them in the competition. We'll just have to wait and see if this *Man Vs Robot* show takes off.



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UM... BUY' NGOP?

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